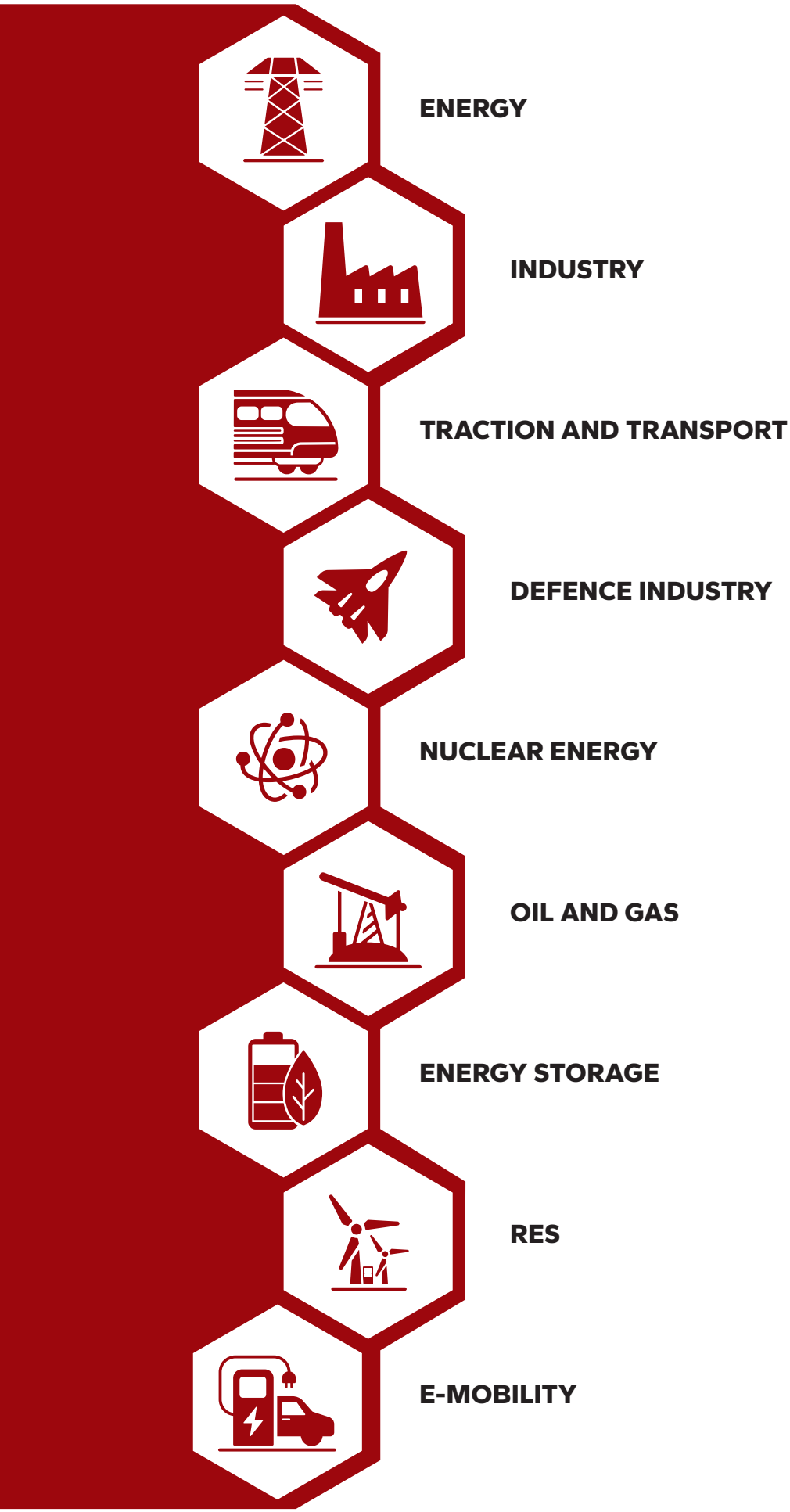
UNINTERUPTIBLE POWER SUPPLY SYSTEMS

ON THE ENERGY MARKET FOR 30 YEARS

PRODUCT CATALOGUE

OUR BUSINESS FIELDS

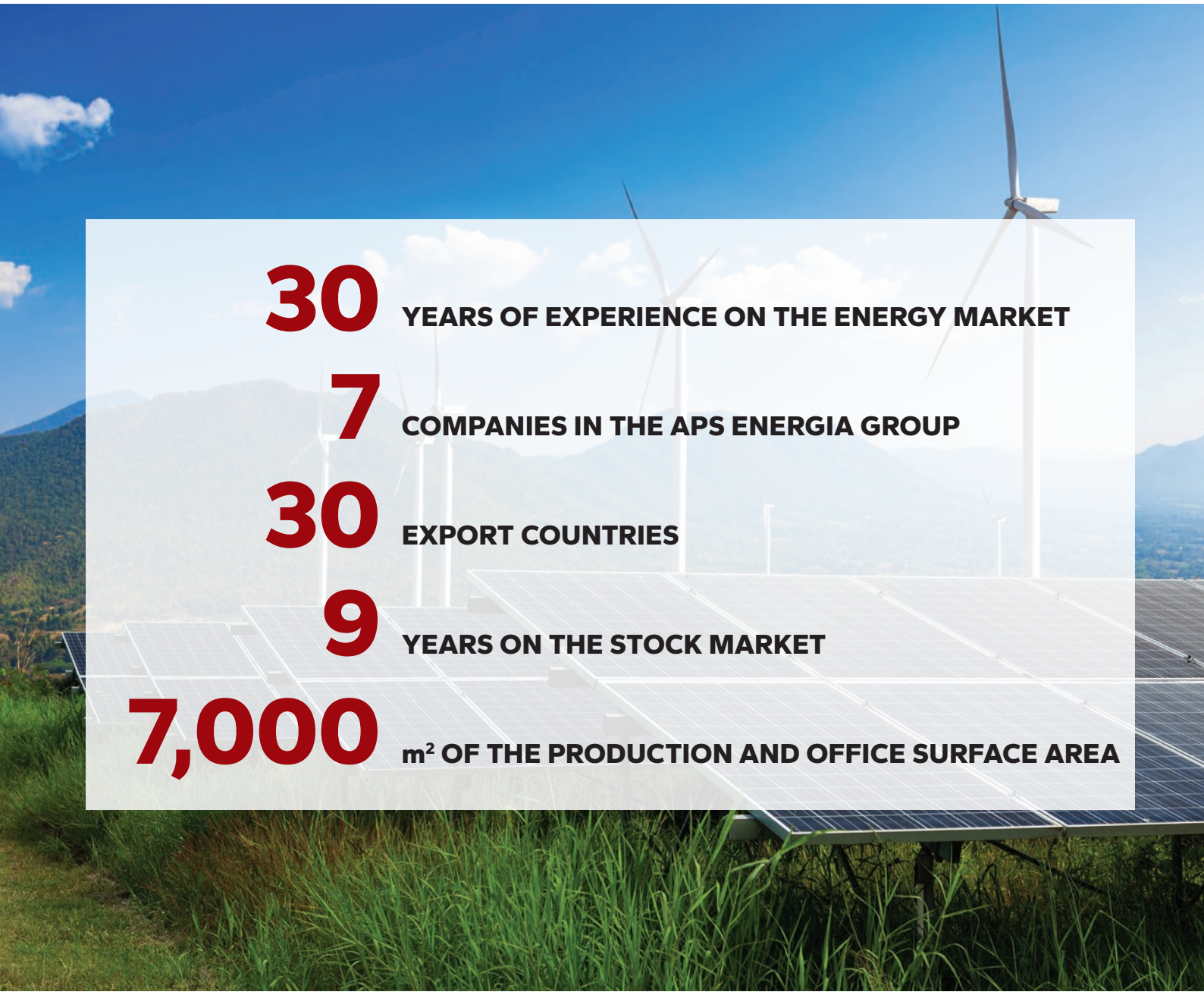


WE SUPPLY. NON-STOP

We design and manufacture guaranteed power supply systems for conventional energy technologies and energy distribution, as well as mining, oil and gas, heavy, nuclear energy, defence, and transport and traction industries.

For 30 years, we have been a reliable partner in securing critical sectors of the economy and industry in Poland and abroad.

We design individual solutions for various power supply systems. Our devices feature high technical parameters, and thus a high quality that helps companies eliminate the power failure risk. Through our team of experienced engineers and cooperation with research centres, we constantly improve our solutions and construct new systems.



30 YEARS OF EXPERIENCE ON THE ENERGY MARKET

7 COMPANIES IN THE APS ENERGIA GROUP

30 EXPORT COUNTRIES

9 YEARS ON THE STOCK MARKET

7,000 m^2 OF THE PRODUCTION AND OFFICE SURFACE AREA

WE HAVE BEEN MANUFACTURING INDIVIDUAL SOLUTIONS FOR YEARS

1995 – Establishment of Advanced Power Systems specialising in production of plasma power supplies

1998 – The first distinction for the FAT system during ENERGETAB fairs. In the next years, we were awarded with prestigious distinctions and certificates

2001 – Expansion of the business to foreign markets: Czech Republic, Kazakhstan, Saudi Arabia. Acquisition of 15 % of shares of ENAP Sp. z o.o.

2008 – Establishment of the following companies: APS Energia RUS, APS Energia Caucasus, APS Energia Kazachstan. Acquisition of 100 % of shares of ENAP Sp. z o.o.

2009/2010 – Transformation of APS Energia Sp. z o.o. into a joint-stock company (Spółka Akcyjna – S.A.)

2011/2012 – Establishment of the following companies:APS Energia Ukraina, APS Energia Czechy

2013 – Debut of NewConnect on the market

2015 – Debut on the Main Floor of the Stock Exchange

2016 – New headquarters of APS Energia in Stanisławów Pierwszy

2017 – Establishment of APS Energia Turcja

2020 – The Economy Award from the President of the Republic of Poland

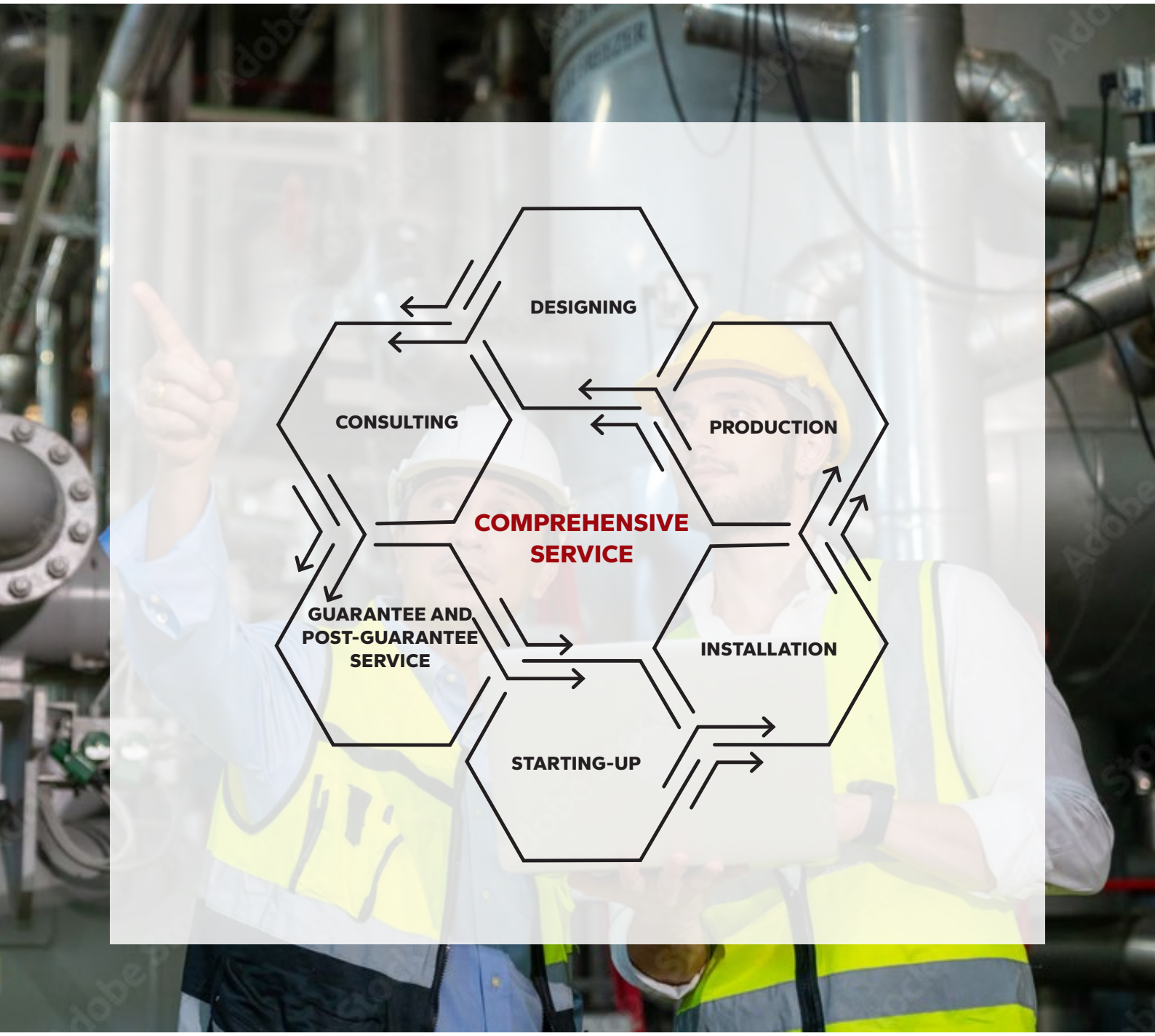
2022 – A new strategy for the APS Energia Group that assumes an active participation in the energy transformation process

WE SPECIALISE IN COMPREHENSIVE SUPPORT

We provide support of highly qualified engineers and specialists at every stage of implementation of a project.

We advise, prepare a solution corresponding to the needs of the Client, manufacture, install, and configure the equipment on site.

We offer a professional guarantee and post-guarantee service. Our advantage is our technical knowledge and market experience, which guarantee high quality and efficient implementation of individual orders.



A QUALITY CONFIRMED BY CERTIFICATES

The high quality of our devices is confirmed by certificates granted by both Polish and international accredited certification bodies.

The systems are subjected to detailed tests in our laboratory or external accredited laboratories. The tests check the resistance of the devices to various factors that may occur during transport, storage, and use. The tests confirm compliance with the European Union's Directives and the national regulations related to safety of products and electromagnetic compatibility.

CERTIFIED
ISO 9001
ISO 14001
ISO 45001

CCJ
AQAP 2110:2016
AQAP 2310:2022

MSWiA Licence no. B-104/2017

NATO
KOD *NCAGE*:
0517H

IRIS Certification

KNOW-HOW

Cooperation with the Warsaw University of Technology and other scientific institutions in Poland and abroad provides us with unlimited access to power electronics solutions.

Combination of scientific knowledge with a team of qualified and experienced engineers is a guarantee of development, improvement of already functioning devices, and creation of new projects.

We organise conferences and scientific and technical seminars where scientists, industry specialists, and entrepreneurs discuss issues associated with the development of the energy sector. We share knowledge and experience with engineers, designers of devices, as well as energy industry exploitation departments.

MAINTENANCE SERVICES

PREVENTIVE AND PERIODIC MAINTENANCE

Regular inspections help to maintain safety and performance of devices, allow decreasing the costs of exploitation through reducing the risk of failure and prolonging the service life of a device.

SERVICE AND PARTNERSHIP CONTRACTS

Regular maintenance prolongs the life cycle of devices, minimises the number of failures, allows maintaining the device in an optimal technical state, and thus ensures their better performance. We offer long- and short-term contracts; we adapt to the needs of our clients.

30 YEARS OF EXPERIENCE

OVER 20,000 START-UPS, INSPECTIONS, AND SERVICE OPERATIONS

5 TYPES OF TRAININGS ON OPERATION AND USE OF DEVICES

A TEAM OF QUALIFIED SPECIALISTS

MAINTENANCE SERVICES IN POLAND AND ABROAD

TESTS, MAINTENANCE, AND CONTROLLED DISCHARGE OF THE BATTERY

The accumulator battery is the last reserve in the case of an accident. Regular checks of the state of the battery ensure safety in the case of power failure in a critical situation.

TRAININGS AND TECHNICAL CONSULTING

The specialists of APS Energia are guaranteed power supply devices maintainers with many years of experience. Trainings with our experts are a dose of necessary knowledge associated with use and operation of the devices. We also provide specialised technical trainings.

STARTING-UP AND ASSISTANCE

Correct connection of the device is crucial for stability and safety of operation of the entire system, as well as its efficiency.

You can count on our specialists. We will visit you, and show you how to do it professionally.

ONGOING REPAIRS, EMERGENCY TROUBLESHOOTING, MODERNISATION

As a producer of devices, we have knowledge, experience, measuring instruments, and spare parts.

SPARE PARTS

Thanks to our wide range of spare parts, our specialists repair devices in the shortest time possible.

TABLE OF CONTENTS

BUFFER RECTIFIERS

A pulse buffer rectifier converts alternating current (AC) to direct current (DC), and constitutes a basic element of guaranteed power supply systems. These industrial direct current power supply system meet high requirements in terms of functionality, technical parameters, and reliability.

Rectifiers are intended for supplying direct current loads and charging accumulator batteries of rated current 24 V, 48V, 60 V, 110 V, 220 V, 400 V, 700 V or other compliant with the device's specification.

Direct current loads power supply may be carried out in cooperation with a buffer battery or directly from a rectifier. The autonomy of the system is ensured by direct connection of the DC bus with the accumulator battery.

THE PBI TYPE BUFFER RECTIFIER CHARACTERISTICS:

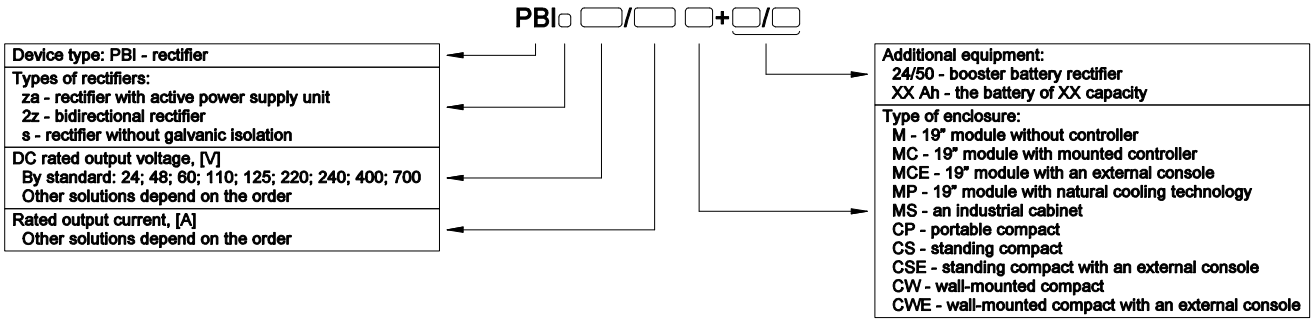
- IGBT technology with a DSP microprocessor controller;
- three operation modes (buffer, automatic, manual);
- high stability of voltages and output currents;
- charging algorithm (as per DIN 41773), accordant with the recommendations of EUROBAT for various types of batteries;
- very low current ripple and output voltage;
- control and limitation of the battery's current;
- battery temperature control;
- battery voltage temperature compensation;
- integrated communication RS485, USB interfaces;
- wide selection of external communication protocols: Modbus RTU, Modbus TCP, IEC 60870-5-103, IEC 61850, SNMP, APS6000, other;
- electromagnetic compatibility (EMI filters);
- parallel operation of the rectifiers with automatic equalisation of currents in all modules;
- galvanic isolation from the mains;
- archiving of events and operating states (SD card);
- modular design;
- silent operation;
- high efficiency;
- monitoring of the ground isolation status of both poles;
- internal overload protection of power systems (limits the output current without removing voltage from the output circuits);
- protection against short-circuit (electronic and fuse type);
- over-current protection.

Views of the rectifier compacts

Views of the rectifier module

Views of the rectifier cabinet

METHOD OF DESIGNATION OF THE PBI TYPE RECTIFIERS



KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BAT – battery	PBI – rectifier
I – current measurement	T – temperature measurement
IN – power supply	VAC – alternating current (AC)
com – communication	VDC – direct current (DC)
OUT – output	

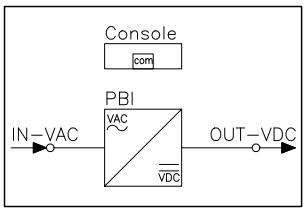


Fig. 1. General block diagram of the rectifier system

THE PBI TYPE BUFFER RECTIFIERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER		VALUE
AC INPUT*		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		-15 % to +10 % (±15 % for 380 V)
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
DC OUTPUT		
Output voltage		24 / 48 / 60 / 110 / 220 / 400 / 700 V
Output voltage stability**		±0.6 %
Output voltage ripple****		±0.6 %
Range of correction of the buffer charging voltage		between -10 and +50 °C
Temperature compensation of the buffer charging voltage**		0 to 10 mV/°C/cell
Rated output current		10 to 1,500 A
Overload capacity		1.1×In for 3 sec
Output current stability***		±1 %
Output current ripple***		±1 %
Battery charging characteristics		IU as per DIN 41773
Total efficiency		>92 %
Available menu language versions		PL | EN | CZ | RU
OPERATING ENVIRONMENT		
Operating temperature (EN 50178 class 3k3)		+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)		-25 to +55 °C*
Humidity (EN 50178 class 3k3)		5 to 85 % (non-condensing)*
Access to the device		operation and maintenance from the front*
Cable entry		from the bottom / from the top****
Maximum height above the sea level without change of the rated parameters		1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;
** – buffer operation, voltage regulator;
*** – battery charging, current regulator;
**** – at resistance load;
***** – only for installation in an industrial cabinet (MS enclosure type).

PBI RECTIFIERS TECHNOLOGY

Three-phase or single-phase power supply voltage is converted in the three-stage converter system.

- mains rectifier,
- high-frequency converter,
- high-frequency rectifier.

The PBI rectifier is equipped with a microprocessor DSP (Digital Signal Processor) control system which controls the operation of the converter and monitors the state of the battery.

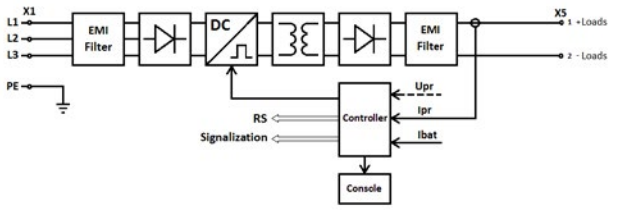


Fig. 2. Conceptual design of the PBI rectifier

The Pulse Width Modulation (PWM) converter ensures adaptation of the input voltage value to the needs of the loads and the battery. The high-frequency ferrite transformer provides a galvanic insulation for the input and output circuits.

Devices are cooled down with a forced air circulation with regulation depending on the temperature of the heat sinks. Operation of the device is monitored by the controller. It also enables communication between the device and the user or master monitoring and control systems.

View of the PBI rectifier power block

PBI RECTIFIER OPERATION MODES

Buffer operation

In this state, the device supplies the battery and/or loads with direct current of high degree of stability and required value (usually 2.23 V/cell). The buffering voltage is compensated thermally by a thermal probe (which must be positioned in the vicinity of the supplied battery) present in the standard equipment. Thanks to this, the output voltage of the power supply is always adapted to the needs of the battery, and maintenance of its fully charged state and readiness for operation in the case of a power supply failure is ensured. During buffer operation, the continuity of the battery's circuit is cyclically checked.

Automatic charging

This function is used in the case of partial or complete discharge of the battery (e.g., as a result of power supply failure), when the battery must be charged as quickly as possible to prepare it for a possible failure. In this case, the power supply will automatically charge the battery to Umax voltage.

Supervised charging

This mode is used in the case of cooperation with open acid batteries, when there is a need to carry out additional equalising charging to 2.7 V/cell. This charging process must be carried out strictly according to the guidelines of the manufacturer of the battery and always in the presence of the operating personnel.

Operation modes parameters

Operation mode	Factory settings		Possible regulation range
	Lead-acid batteries	Ni-Cd batteries	
Buffer mode (Float mode)	2.23 V/cell	1.41V/cell	0.8 – 2.4 V/cell
Automatic charging (Boost mode)	2.40 V/cell	1.50 V/cell	0.8 – 2.7 V/cell
Supervised charging (Equalising mode)	2.70 V/cell	1.80 V/cell	0.8 – 2.7 V/cell

Three-stage I_1 U_1 U_2 battery charging technique

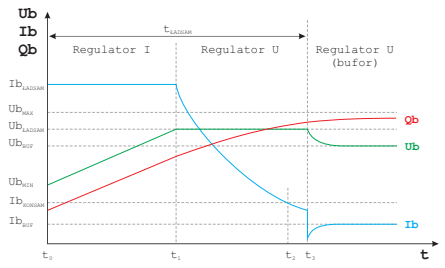
In the case of discharge of the battery, the PBI rectifier will automatically activate the quick charging mode (optionally, this mode may be activated manually). The charging parameters are configured in the memory of the rectifier in accordance with the requirements of the producer of the battery of a given type. The charging has three stages:

1st phase – direct current charging I_1 (the first limit parameter): this is a current-limited charging. The rectifier gradually increases the battery voltage to not exceed the recommended charging current (most often, limitation at the level of current I_1 = 5÷10-hour charging (I_{C10}) is used);

2nd phase – direct current charging U_1 (the second limit parameter): the battery is partially charged after the first phase of charging, there is no risk that the increase of the charging voltage will exceed the set battery current I_1, the second limit parameter works, the allowed (maximum voltage at the DC bus due to loads or due to the battery) voltage U_1. Completion of the 2nd phase of charging depends on the adopted algorithm. APS Energia SA uses the DBC method.

3rd phase – direct current charging U_2; the system has completed quick charging, and the rectifier switches to voltage U_2 = Ubuf buffer voltage.

Charging characteristics DBC (Dynamic Charge Characteristic) model



Configurable parameters:

- charging current – Ib_{C10}
- maximum voltage – Ub_{MAX},
- recharge current – Ib_{DOL},
- time of automatic charging – T_2,

In accordance with the recommendations of EUROBAT.As per DIN 41773.

DBC charging method

The DBC is a charging method developed by APS Energia SA based on the experience in production of buffer rectifiers and in strict cooperation with the manufacturers and users of batteries. The Dynamic Battery Charging (DBC) is a method which controls all charging parameters, and thus ensures quick replenishment of the battery's electric charge according to all recommendations of the producer of a given type of cell. The method consists in charging the battery with voltage U_1 in the second phase until the two following criteria are met at the same time:

- criterion no. 1 – achievement of the set value (e.g., 0.2×I_{C10}) by the dropping charging current – a configurable parameter;
- criterion no. 2 – charging of the battery after the criterion no. 1 has been met for 30 minutes – a configurable parameter;

As an option of the DBC method, an additional criterion of completion of the quick completion phase is assumed, i.e., the length and the depth of the battery's discharge.

PBI RECTIFIER FUNCTION DESCRIPTION	
Battery current measurement	This system measures the battery circuit current using a transducer. The transducer may be located inside the power supply (internal current measurement) or outside the power supply (external current measurement), e.g., in the user's distribution board or at the battery itself, on any pole.
Battery circuit continuity test	In the buffer operation state, the rectifier cyclically tests the continuity of the battery's circuit. The process is carried out by way of appropriate regulation of voltage and current measurements. After a positive test result, the rectifier's voltage goes back to the buffer voltage level. The test parameters are set in the rectifier's menu.
Charging interlock	Switching the rectifier into the "charging interlock" mode limits the current flowing to the battery at the 100-hour current level. This function is tripped by applying voltage to the binary input. The charging interlock limits the current during the automatic charging and supervised charging. This function is most often used with another system, e.g., a battery room's ventilation system. Failure of the ventilation generates a signal to the "charging interlock" to limit the charging current, and thus protect the battery against potential overheating, increased aeration of the electrolyte, etc.
Rectifier operation interlock	In this mode, the rectifier does not transfer energy from the mains to the loads and the battery, and only remains in the standby mode. The rectifier will start automatically after the "rectifier interlock" signal has been removed. This function is tripped by applying voltage to the binary input. This function is necessary if the rectifier must be controlled remotely.
Over-voltage protection of the load	When a voltage dangerous to loads is present for a time longer than 500 ms at the power supply's output, an overcurrent protection is activated to turn the rectifier off. This voltage is preset appropriately to the rated voltage of the power supply. After the excessively high voltage at the input ceases, the rectifier restarts.
Charger alarm levels	All of the set alarm levels have hysteresis of the system on the level of alarm stimulation.
Battery voltage thermal compensation	The battery's buffer voltage changes with the temperature fluctuations. In accordance with the recommendations of the battery manufacturers, the battery's charging voltage thermal compensation is applied. The rectifier may carry out a procedure of automatic temperature compensation to adapt the battery's voltage to the environmental conditions.
Limitation of the battery charging current	The rectifier limits the battery's charging current to the value set by the user and expressed by the time in which we want to charge the battery. During the supervised charging, the current is limited to the value set by the personnel when configuring the supervised charging parameters.
Battery earth fault isolation resistance	The rectifier is equipped with a microprocessor earth fault control system. The earth fault control system is intended for measuring the value of the insulation resistance in the direct current installation circuits (the battery's poles ground faults control). The device measures and signals a drop of the symmetrical and asymmetrical resistance. A drop of the value of resistance below the warning or alarm threshold is signalled in the status of the device and trips relevant alarm relays.
Auto-restart	The PBI rectifiers are equipped with an auto-restart function when the power supply voltage appears, if a power supply voltage break caused the rectifier to turn off.
Fans operation control	The fans installed in the modules are equipped with damage sensors. Stoppage of the fans is signalled by illumination of the "warning" diode on the rectifier's console. Information about the damage is stored in the event buffer. There is a possibility to signal such a state using relay outputs.
Controlled cabinet fans	The MS version PBI rectifier allows controlling the operation of the roof fans. The roof fans (which extract air from inside the cabinet) may work in two speeds. Application of alternating current power supply starts the fans on the 1st speed. When the temperature inside the cabinet exceeds the 2nd speed tripping threshold of the roof fans, their efficiency of extraction of hot air from inside the cabinet will increase.
Data archiving	The events buffer is an area in the permanent memory of the rectifier, in which all alarm events, including date and time, are saved. The archive buffer is an area of the permanent memory of the rectifier, in which measurement series are stored with an interval set by the user. USB 2.0 ports enable communication between the power supply and the computer system or transferring alarm logs to a FLASH portable memory (USB flash drive).
Communication with the user	Communication between the user and the device may take place both locally and remotely. Locally, using the console (keyboard, LCD, indicating diodes), located on the front side of the device. Electrical parameters are displayed constantly, regardless of the selected operation mode of the panel. Alarm states are indicated using glowing diodes and the display. Additionally, a sound signal is generated, which informs about an alarm state (the sound signaller is located behind the panel's board). Remotely, using the binary inputs and outputs, as well as communication ports. You may assign different functions to the binary inputs to change the operation of the rectifier. The functions are assigned in the rectifier's menu. The transmission communication ports (RS485, USB) allow connecting multiple transmitters and loads. The following transmission protocols are available at the rectifier's connections: Selected from the controller's menu: APS6000, Modbus RTU, IEC 60870-5-103. Available with the converter: IEC 61850, PROFIBUS DP, SNMP, Modbus TCP. They allow to read the full set of data from the rectifier.
Parallel operation of rectifiers	During operation on the common load bus, all PBI type rectifiers automatically and evenly distribute the load between each other by equalising the output currents.
Self-test	Thanks to the "self-test" function, the user obtains information about correctness of internal and intermediate parameters responsible for proper operation of the device.
Soft Start	Thanks to the "Soft Start" function, when the rectifier starts-up, there is no sudden load of the power supply lines. The soft start of the rectifier is carried out in two stages: in the first one, the condensers are loaded and the rectifier's controls are started-up, and then the rectifier gradually increases the voltage at the output until reaching the operating point. The soft start cycle lasts several to a dozen or so seconds depending on the load.

THERE ARE TWO VARIANTS OF THE PBI RECTIFIERS:

• RECTIFIERS WITH AN INTERNAL BATTERY CURRENT MEASUREMENT (WPP)

Rectifiers with an internal current measurement (WPP) are characterised by a separation of outputs of loads (X5) and the battery's output (X4) inside the rectifier. Current measurement takes place inside the rectifier without the necessity to use an external current measurement transducer. The battery output and the loads output are protected with fuses.

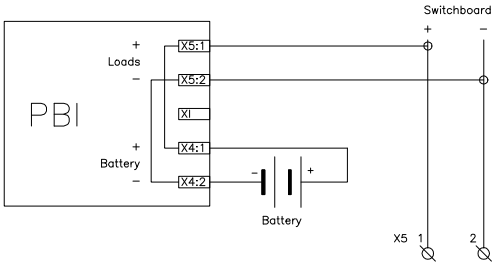


Fig. 3. A rectifier with an internal battery current measurement

• RECTIFIERS WITH AN EXTERNAL BATTERY CURRENT MEASUREMENT (ZPP)

The rectifiers with an external current measurement (ZPP) require connection of an external current measurement transducer to the XI connector of the rectifier. The rectifier has a single output (X5), common for the battery and the loads. The battery's circuits and the loads must be separated in an external distribution board.

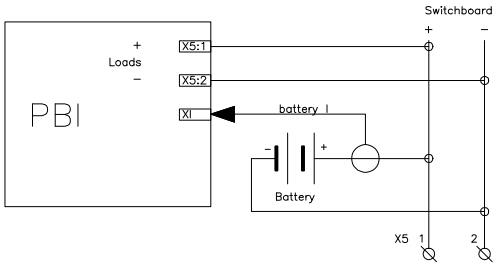


Fig. 4. A rectifier with an external battery current measurement

OPTIONAL ACCESSORIES FOR THE PBI TYPE RECTIFIERS

Optional	Equipment	Description
Special designs	Upon request, it is possible to adapt the devices to special requirements of a given project in relation to:	
	Module, cabinet, compact	• greater DC rated currents; • standard of voltages and frequencies of AC power supply: (110 / 190 V, 115 / 200 V, 120 / 208V, 127/220 V, 50 / 60 Hz); • level of the DC output voltages; • extension of the range of input voltages;
	Cabinet, compact	• environmental requirements related to ambient temperature (-20 °C to +55 °C), presence of aggressive factors, etc.;
	Cabinet	• enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.;
	Cabinet, compact	• measurements and communication: digital or analogue meters of appropriate class, indication of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.
Automatic load disconnection	Module, cabinet, compact	The PBI rectifier may be equipped with a contactor that disconnects loads when the battery's voltage drops below the value set via the "load disconnection" parameter. The loads will remain disconnected until the rectifier's voltage reaches the level above the "connection of loads" parameter.
Measurement of the charge accumulated in the battery		The charge is calculated during charging and discharging of the battery considering the battery charging efficiency coefficient. The user may set the current parameters of the battery (e.g., after a controlled discharge); these parameters will be the starting point for calculation of the charge.
Counter cell system	Cabinet, compact	The counter cell consists of diodes connected in series and bypassed by the contactor's pin. This is a system that allows lowering of voltage in DC loads. Voltage on the load bus is reduced by activation of the serial diode stack at the output of the loads. When the battery's voltage drops (e.g., when the rectifier turns off), the contactor closes the diode stack circuit. The voltage of loads is equal to the voltage of the battery. The counter cell system may be controlled based on the power supply voltage break or drop of the battery's voltage.
Active input filter (sinusoidal input current from the mains)	Cabinet	To improve THDi of the current drawn from the mains, you may use another parallel active filter or a serial active power supply in the rectifier. By using this solution, you achieve sinusoidal characteristics of drawing of current from the mains by the rectifier.
ATSE system		The automatic transfer switching equipment (ATSE) decides about the selection of the source of power for a device. During presence of the voltage of the source no. 1, the rectifier is supplied by it. In the case of break (a complete or of one of the phases) of the source no. 1, the ATSE automatically switches supply of the rectifier to the source no. 2.
The system of connecting the booster battery		The PBI rectifiers may be equipped with a booster battery connecting system in a series with the main battery. Connection and disconnection take place without interruptions (from the point of view of loads). The booster battery is connected after the voltage of the main battery drops to the specified level, and is disconnected when the voltage of the main battery increases. Connection and disconnection take place automatically. The booster battery may be connected to the positive or negative pole of the main battery (depending on the design specification).
Cable entry from the top		It is possible to design the enclosure in a way to allow cables entering from the top.

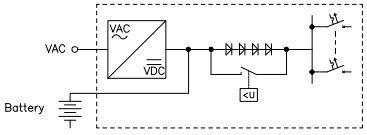


Fig. 5. A rectifier with an internal battery current measurement and the counter cell system

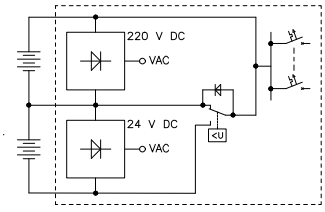


Fig. 6. A rectifier with an internal battery current measurement and the booster battery

MODULAR DESIGN RECTIFIERS

This chapter presents the PBI type rectifiers in a form of a 19" module. They are adapted for mounting in industrial cabinets. The main task of a rectifier is to continuously supply loads with a guaranteed DC voltage.

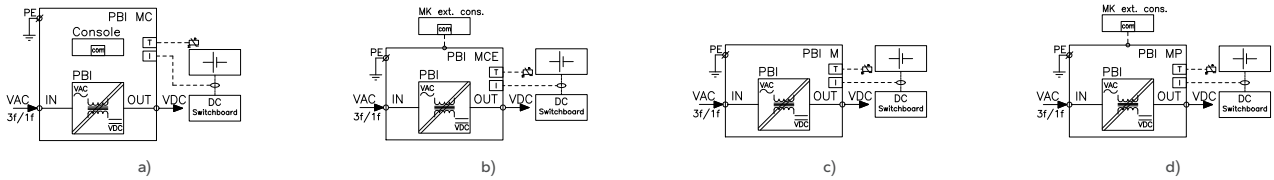


Fig. 7. Block diagram of the PBI type rectifier module for autonomous operation:
a) with a built-in console; b) with an external MK console; c) without a console; d) with natural cooling.

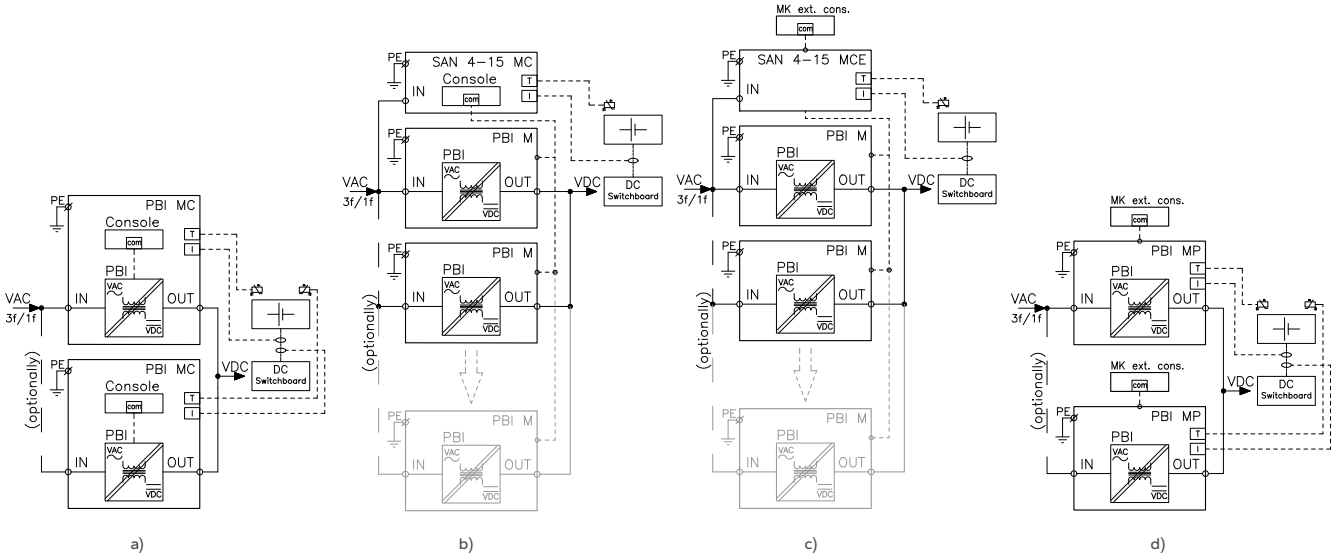


Fig. 8. Block diagram of the modules of the PBI type rectifier for parallel operation:
a) the PBI MC type modules system; b) the PBI M modules and the SAN 4-15 MC type controller system;
c) the PBI M type modules and the SAN 4-15 MCE type controller system including an external MK console; d) the PBI MP type modules system.

The PBI type rectifier module is supplied by a single-phase or three-phase AC mains. The modules with a built-in console belong to the MC modules family (Fig. 7a), the modules with an external MK console belong to the MCE modules family (Fig. 7b), and the modules without the console are a part of the M modules family (Fig. 7c).

The rectifier converts alternating current to direct current of a value according to the order. The galvanic isolation of the rectifier's output voltage from the AC supply voltage is ensured by the high-frequency isolating transformer located in the mains converter.

The devices may operate on their own (autonomously – Fig. 7) or in n×PBI configuration (in parallel – Fig. 8). The PBI MC, PBI MCE, and PBI MP modules for parallel operation do not require an external controller. The PBI M modules are adapted to parallel operation via use of an external controller in systems consisting of a larger number of modules (>4).

The SAN 4-15 external controller module is used to control, supervise, visualise operating and emergency states of the system. The SAN 4-15 modules in a version with a built-in console belong to the MC family (Fig. 8b), while the modules with an external console are a part of the MCE modules family (Fig. 8c) of overall dimensions of the M4 module shown on Figure 9a, c).

When the rectifier is only used to supply loads with output DC voltage, this device will be configured without functions related to the battery.

Each M or MC module is cooled using fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime. While the MP family modules (Fig. 7 d and Fig. 8 d) are cooled by the natural air circulation (passive cooling).

SERIES TYPE: RECTIFIER MODULE 10 ÷ 350 A FOR AUTONOMOUS AND PARALLEL OPERATION:

Rated output current, [A]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions**
25 / 30 / 50 / 75 / 100 / 150 / 200	24	3×400 or 230	PBI 24/25 MC*	M4
250 / 300 / 350		3×400	PBI 24/250 MC*	
60		3×400 or 230	PBI 24/60 MP	M3-MP
25 / 30 / 50 / 75 / 100	48		PBI 48/25 MC*	M4
150 / 200		3×400	PBI 48/150 MC*	
250 / 300 / 350			PBI 48/250 MC*	M3
30		3×400 or 230	PBI 48/30 MP	M3-MP
25 / 30 / 50 / 60	60		PBI 60 / 25 MC*	M4
75 / 100 / 150		3×400	PBI 60/75 MC*	
200 / 250 / 300			PBI 60 / 200 MC*	M3
10 / 20 / 25 / 30 / 50	110	3×400 or 230	PBI 110 / 10 MC*	M4
60 / 75 / 80 / 100		3×400	PBI 110 / 60 MC*	
150 / 200			PBI 110 / 150 MC*	M3
20			PBI 110 / 20 MP	M3-MP
10 / 20 / 25 / 30 / 40 / 50	125	3×400 or 230	PBI 125/10 MC*	M4
75		3×400	PBI 125/75 MC*	
100 / 150			PBI 125/100 MC*	M3
10 / 20 / 25	220	3×400 or 230	PBI 220 / 10 MC*	M4
30 / 50		3×400	PBI 220/30 MC*	
60 / 75 / 80 / 100			PBI 220 / 60 MC*	M3
10			PBI 220 / 10 MP	M3-MP
10 / 20	240	3×400 or 230	PBI 240 / 10 MC*	M4
25 / 30 / 40		3×400	PBI 240 / 25 MC*	
50 / 75 / 80			PBI 240/50 MC*	M3
10 / 20 / 25	400		PBI 400 / 10 MC*	M4
30 / 50 / 60			PBI 400/30 MC*	M3
25	700		PBI 700 / 25 MC*	

* – Possible options: M / MC / MCE;

** – M4 (4U): 482×142×496; M3 (6U): 482×267×496. (W×H×D).

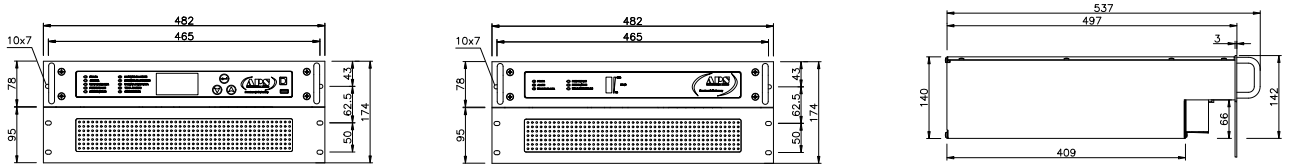


Fig. 9. Views with dimensions of the M/MC/MCE PBI rectifier module in the M4 enclosure:
a) front view – a module with a built-in console; b) front view – a module without a console; c) left-side view.

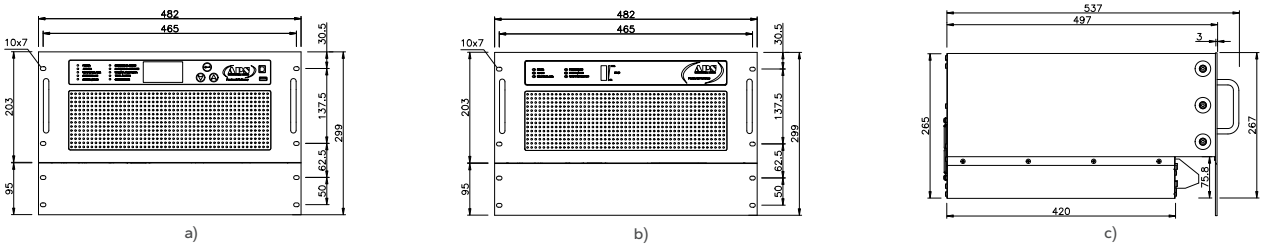


Fig. 10. Views with dimensions of the M/MC/MCE PBI rectifier module in the M3 enclosure:
a) front view – a module with a built-in console; b) front view – a module without a console; c) left-side view.

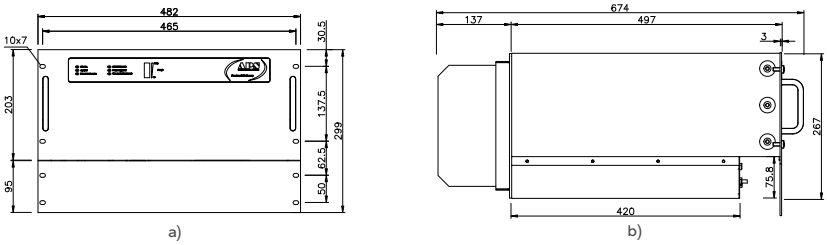


Fig. 11. Views with dimensions of the MP PBI type rectifier module in the M3-MP enclosure:
a) front view; b) left-side view.

RECTIFIERS BUILT IN A CABINET

This chapter presents the PBI type rectifiers in a form of a 19" industrial cabinet for installation on a substrate. The main task of a rectifier is to continuously supply loads with a guaranteed DC voltage.

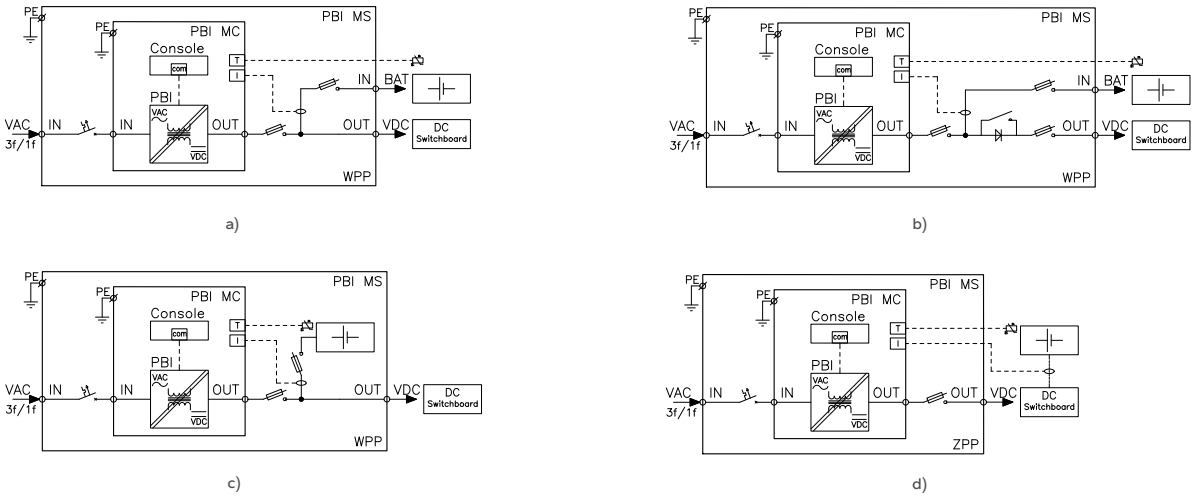


Fig. 12. Block diagram of the PBI type rectifier cabinet for autonomous operation:
a) a system with WPP; b) a system with WPP and a counter cell; c) a system with WPP and an external battery in the rectifier's cabinet; d) a system with ZPP.

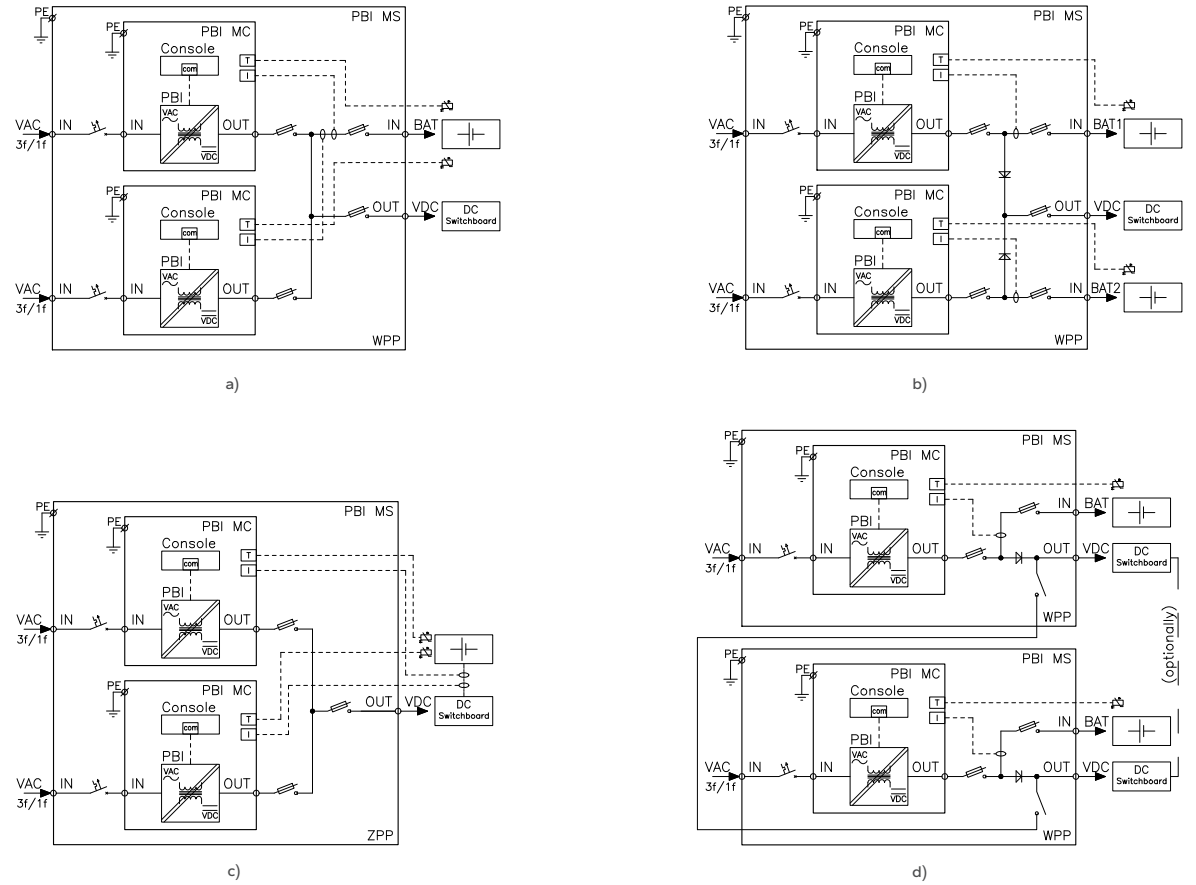


Fig. 13. Block diagram of the PBI type rectifier cabinet (on the basis of the PBI MC modules) for parallel operation:
a) the PBI MC system with WPP for operation with a single battery; b) the PBI MC system with WPP for operation with two batteries;
c) the PBI MC system with ZPP; d) the PBI MS system for operation with two batteries.

The PBI MS type rectifiers are multi-modular power supply systems intended for supplying loads in cooperation or without cooperation with the battery. The design of the rectifier is based on rectifier modules of PBI M or MC types. The description of the modules is provided in the chapter "MODULAR DESIGN RECTIFIERS". The modules feature a compact design, optimised for operating conditions of the modules. The functionality of the PBI MS systems allows designing rectifiers of significant output power, as well as more complex systems.

Fig. 12 – Fig. 14 present a standard solution for modular rectifiers built in an industrial cabinet. The devices may operate on their own (autonomously – Fig. 12) or in n×PBI configuration (in parallel – Fig. 13, Fig. 14).

Fig. 12 b) presents a cabinet with an additional option – a counter cell system (for details, see tab. "OPTIONAL ACCESSORIES FOR THE PBI TYPE RECTIFIERS").

The rectifier converts alternating current to direct current of a value according to the order. The galvanic isolation of the rectifier's output voltage from the AC supply voltage of the rectifier is ensured by the high-frequency isolating transformer located in the mains converter.

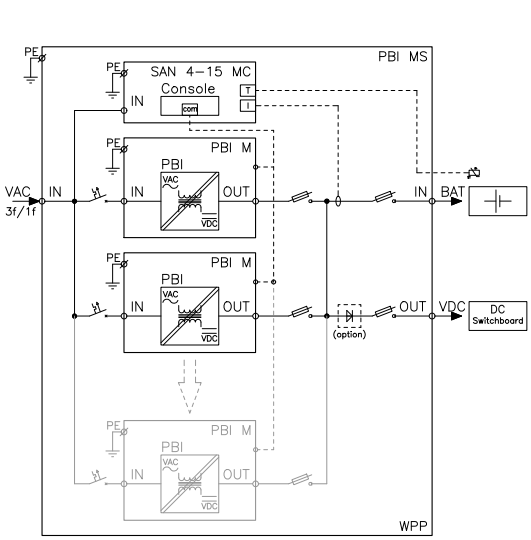
The system presented in Fig. 13 a) may have up to 4 PBI MC type rectifier modules.

The system presented in Fig. 14 may have up to 16 PBI M type rectifier modules.

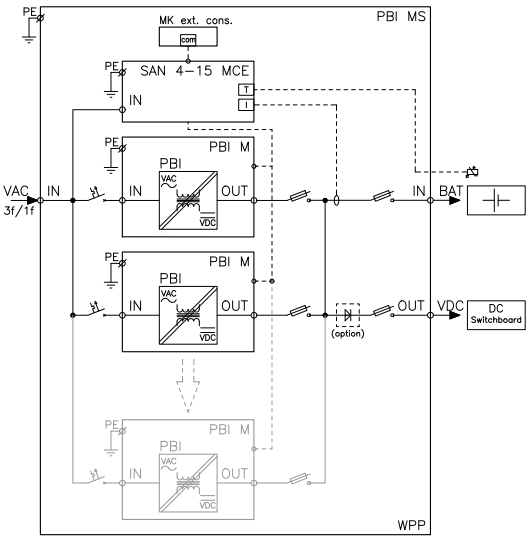
Use of the blocking diode presented in Fig. 13 b), d), and Fig, 14 a), b) allows connecting two systems for parallel operation with two batteries.

When the rectifier is only used to supply loads with an output DC voltage, this device will be configured without functions related to the battery.

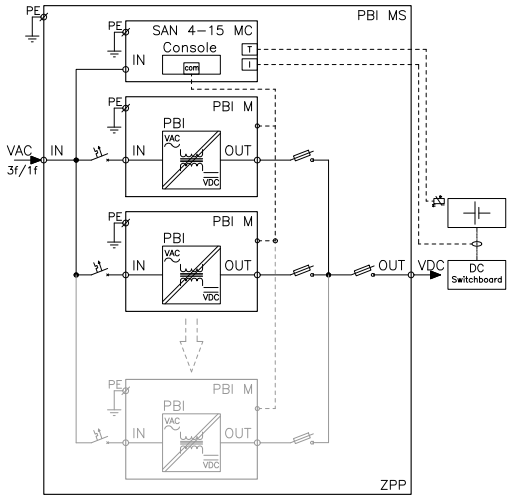
The industrial cabinet is cooled by a forced air circulation via redundant roof fans. Moreover, each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.



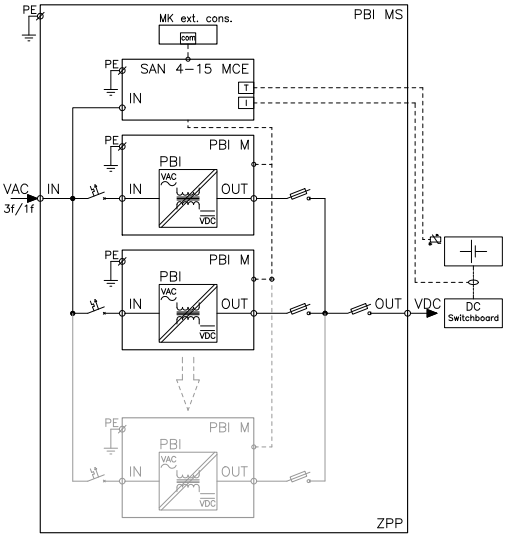
a)



b)



c)



d)

Fig. 14. Block diagram of the PBI type rectifier cabinet (on the basis of the PBI M modules) for parallel operation:
d) the PBI M type modules and the SAN 4-15 MC type controller system with WPP; b) the PBI M type modules and the SAN 4-15 MCE type controller system with WPP;
c) the PBI M type modules and the SAN 4-15 MC type controller system with ZPP; d) the PBI M type modules and the SAN 4-15 MCE type controller system with ZPP.

SERIES TYPE: RECTIFIER CABINETS 10 ÷ 1500 A FOR AUTONOMOUS AND PARALLEL OPERATION WITH WPP*

Rated output current, [A]	DC rated output voltage, [V]	AC rated input voltage, [V]	Example type	Modules configuration	Max. enclosure dimensions [W×D×H**], [mm]
25	24	3×400 or 230 (for modules with output current max. 200 A)	PBI 24/25 MS	1×25 A	600×800×2,000
30			PBI 24/30 MS	1×30 A	
50			PBI 24/50 MS	1×50 A	
				2×25 A	
75			PBI 24/75 MS	1×75 A	
100			PBI 24/100 MS	1×100 A	
				2×50 A	
200			PBI 24/200 MS	1×200 A	
				2×100 A	
250			PBI 24/250 MS	1×250 A	
300			PBI 24/300 MS	1×300 A	
				2×150 A	
400			PBI 24/400 MS	2×200 A	
				4×100 A	
500			PBI 24/500 MS	2×250 A	
				3×200 A	800×800×2,000
				5×100 A	1,200×800×2,000
600			PBI 24/600 MS	2×300 A	800×800×2,000
				3×200 A	
				6×100 A	1,200×800×2,000
700			PBI 24/700 MS	2×350 A	
				3×250 A	
				7×100 A	1,400×800×2,000
1,000			PBI 24/1000 MS	3×350 A	
				4×250 A	
1,200			PBI 24/1200 MS	4×300 A	1,800×800×2,000
1,500			PBI 24/1500 MS	5×300 A	2,400×800×2,000
				6×250 A	
25	48	3×400 or 230 (for modules with output current max. 100 A)	PBI 48/25 MS	1×25 A	600×800×2,000
30			PBI 48/30 MS	1×30 A	
50			PBI 48/50 MS	1×50 A	
				2×25 A	
75			PBI 48/75 MS	1×75 A	
100			PBI 48/100 MS	1×100 A	
				2×50 A	
150			PBI 48/150 MS	1×150 A	
				2×75 A	
200			PBI 48/200 MS	1×200 A	
				2×100 A	
300			PBI 48/300 MS	1×300 A	
				2×150 A	
400			PBI 48/400 MS	2×200 A	
				4×100 A	
500			PBI 48/500 MS	2×250 A	800×800×2,000
				5×100 A	1,200×800×2,000
600			PBI 48/600 MS	2×300 A	800×800×2,000
				6×100 A	1,200×800×2,000
700			PBI 48/700 MS	2×350 A	
				7×100 A	1,400×800×2,000
1,000			PBI 48/1000 MS	3×350 A	
				5×200 A	
1,200			PBI 48/1200 MS	4×350 A	1,800×800×2,000
				6×200 A	
1,500			PBI 48/1500 MS	5×300 A	2,400×800×2,000

SERIES TYPE: RECTIFIER CABINETS 10 ÷ 1500 A FOR AUTONOMOUS AND PARALLEL OPERATION WITH WPP* – CONTINUED

Rated output current, [A]	DC rated output voltage, [V]	AC rated input voltage, [V]	Example type	Modules configuration	Max. enclosure dimensions [W×D×H**], [mm]
25	60	3×400 or 230 (for modules with output current max. 60 A)	PBI 60 / 25 MS	1×25 A	600×800×2,000
30			PBI 60/30 MS	1×30 A	
50			PBI 60/50 MS	1×50 A	
60			PBI 60 / 60 MS	1×60 A	
				2×30 A	
75			PBI 60/75 MS	1×75 A	
100			PBI 60 / 100 MS	1×100 A	
				2×50 A	
150			PBI 60 / 150 MS	1×150 A	
				2×75 A	
200			PBI 60 / 200 MS	1×200 A	
				2×100 A	
250			PBI 60 / 250 MS	1×250 A	
300			PBI 60/300 MS	1×300 A	
				2×150 A	
				3×100 A	
400			PBI 60 / 400 MS	2×200 A	
				4×100 A	
500			PBI 60/500 MS	2×250 A	800×800×2,000
				5×100 A	1,200×800×2,000
600			PBI 60 / 600 MS	2×300 A	800×800×2,000
				6×100 A	1,200×800×2,000
700			PBI 60/700 MS	4×200 A	
				7×100 A	1,400×800×2,000
1,000			PBI 60 / 1000 MS	4×250 A	
1,200			PBI 60 / 1200 MS	6×200 A	2,000×800×2,000
1,500			PBI 60 / 1500 MS	5×300 A	2,400×800×2,000
10	110	3×400 or 230 (for modules with output current max. 50 A)	PBI 110 / 10 MS	1×10 A	600×800×2,000
20			PBI 110 / 20 MS	1×20 A	
25			PBI 110 / 25 MS	1×25 A	
30			PBI 110/30 MS	1×30 A	
50			PBI 110/50 MS	1×50 A	
				2×25 A	
75			PBI 110/75 MS	1×75 A	
100			PBI 110 / 100 MS	1×100 A	
				2×50 A	
150			PBI 110 / 150 MS	1×150 A	
				2×75 A	
200			PBI 110 / 200 MS	1×200 A	
				2×100 A	
300			PBI 110/300 MS	2×150 A	
				3×100 A	
400			PBI 110 / 400 MS	2×200 A	
				4×100 A	
500			PBI 110/500 MS	5×100 A	1,200×800×2,000
600			PBI 110 / 600 MS	3×200 A	800×800×2,000
				6×100 A	1,200×800×2,000
700			PBI 110/700 MS	7×100 A	
800			PBI 110/800 MS	4×200 A	
				8×100 A	
900			PBI 110/900 MS	9×100 A	1,800×800×2,000
1,000			PBI 110 / 1000 MS	5×200 A	1,400×800×2,000
				10×100 A	1,800×800×2,000
1,100			PBI 110 / 1100 MS	11×100 A	2,400×800×2,000
1,200			PBI 110 / 1200 MS	6×200 A	1,800×800×2,000
1,400			PBI 110 / 1400 MS	7×200 A	
1,500			PBI 110 / 1500 MS	8×200 A	2,000×800×2,000

SERIES TYPE: RECTIFIER CABINETS 10 ÷ 1500 A FOR AUTONOMOUS AND PARALLEL OPERATION WITH WPP* – CONTINUED

Rated output current, [A]	DC rated output voltage, [V]	AC rated input voltage, [V]	Example type	Modules configuration	Max. enclosure dimensions [W×D×H**], [mm]
10	125	3×400 or 230 (for modules with output current max. 40 A)	PBI 125/10 MS	1×10 A	600×800×2,000
20			PBI 125 / 20 MS	1×20 A	
25			PBI 125 / 25 MS	1×25 A	
30			PBI 125/30 MS	1×30 A	
40			PBI 125/40 MS	1×40 A	
				2×20 A	
50			PBI 125/50 MS	1×50 A	
				2×25 A	
60			PBI 125/60 MS	1×60 A	
				2×30 A	
80			PBI 125/80 MS	2×40 A	
120			PBI 125/120 MS	2×60 A	
				3×40 A	
150			PBI 125/150 MS	1×150 A	
				2×75 A	
200			PBI 125 / 200 MS	2×100 A	
				3×75 A	
300			PBI 125/300 MS	2×150 A	
				3×100 A	1,200×800×2,000
400			PBI 125/400 MS	3×150 A	
				6×75 A	
600			PBI 125/600 MS	4×150 A	
				6×100 A	1,800×800×2,000
700			PBI 125/700 MS	5×150 A	
900			PBI 125/900 MS	6×150 A	
1,000			PBI 125/1000 MS	7×150 A	2,000×800×2,000
1,200			PBI 125/1200 MS	8×150 A	2800×800×2,000
1,500			PBI 125/1500 MS	10×150 A	3400×800×2,000
10	220	3×400 or 230 (for modules with output current max. 25 A)	PBI 220 / 10 MS	1×10 A	600×800×2,000
20			PBI 220 / 20 MS	1×20 A	
25			PBI 220 / 25 MS	1×25 A	
30			PBI 220/30 MS	1×30 A	
50			PBI 220/50 MS	1×50 A	
				2×25 A	
60			PBI 220 / 60 MS	1×60 A	
				2×30 A	
75			PBI 220/75 MS	1×75 A	
80			PBI 220/80 MS	1×80 A	
100			PBI 220 / 100 MS	1×100 A	
				2×50 A	
150			PBI 220 / 150 MS	2×75 A	800×800×2,000
200			PBI 220 / 200 MS	2×100 A	
300			PBI 220/300 MS	3×100 A	
400			PBI 220 / 400 MS	4×100 A	1,800×800×2,000
500			PBI 220/500 MS	5×100 A	
600			PBI 220 / 600 MS	6×100 A	
700			PBI 220/700 MS	7×100 A	2,600×800×2,000
800			PBI 220/800 MS	8×100 A	
900			PBI 220/900 MS	9×100 A	
1,000			PBI 220 / 1000 MS	10×100 A	4,600×800×2,000
1,100			PBI 220 / 1100 MS	11×100 A	
1,200			PBI 220 / 1200 MS	12×100 A	
1,300			PBI 220 / 1300 MS	13×100 A	5,200×800×2,000
1,400			PBI 220 / 1400 MS	14×100 A	
1,500			PBI 220 / 1500 MS	15×100 A	

* – for rectifier cabinets with ZPP, the overall dimensions may be lesser than the ones provided in the table;

** – add the height of the pedestal to the height of the device: by standard, 100 mm.

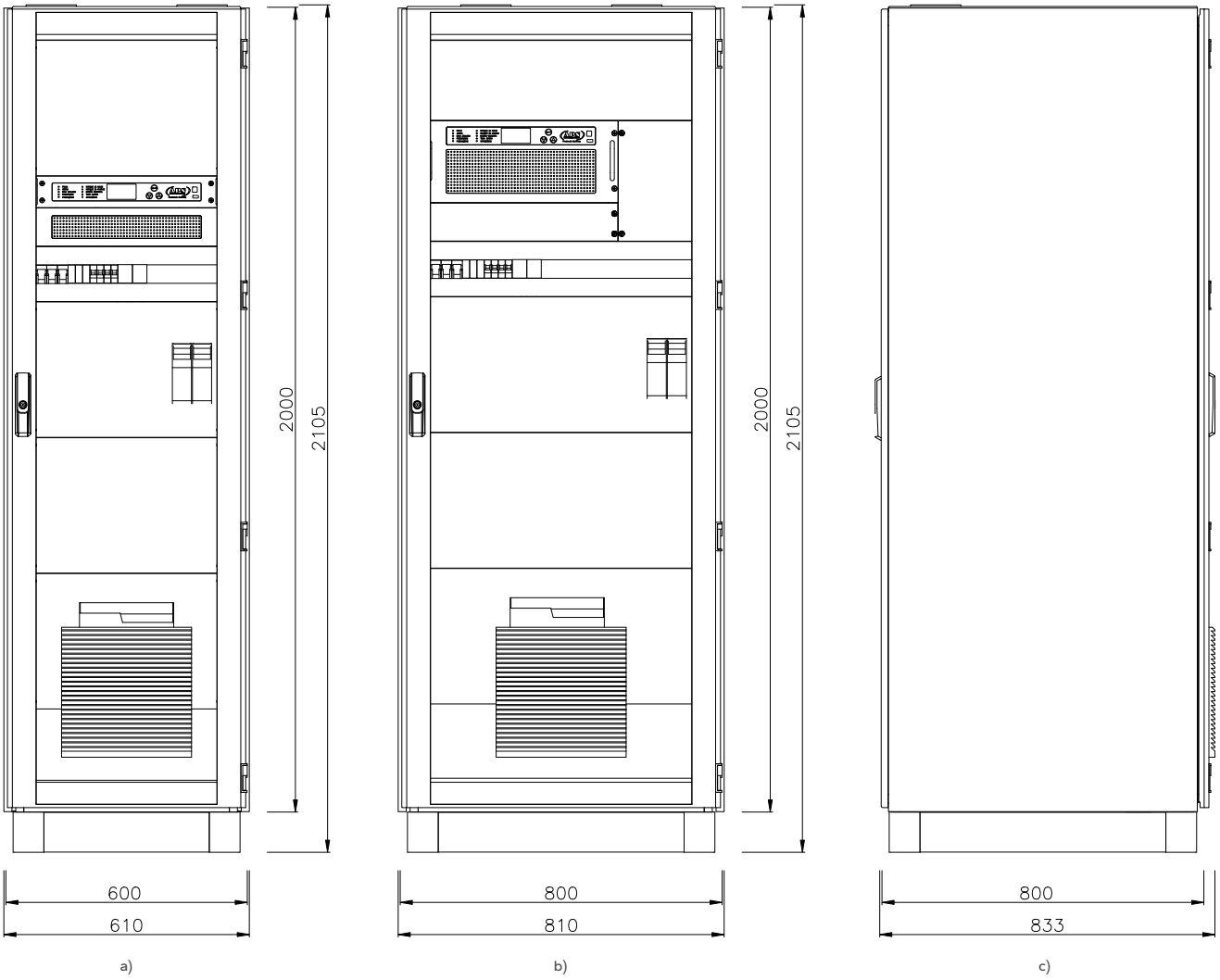


Fig. 15. Views with dimensions of the PBI type rectifier cabinet:
a) 600×800×2,000 cabinet – front view; b) 800×800×2,000 cabinet – front view; c) cabinet of depth of 800 mm – left-side view.

COMPACT DESIGN RECTIFIERS

This chapter presents the PBI type rectifiers in a compact form. They are intended for installation on a substrate (CS standing compact) or on a wall (CW wall-mounted compact). The main task of a rectifier is to continuously supply loads with a guaranteed DC voltage.

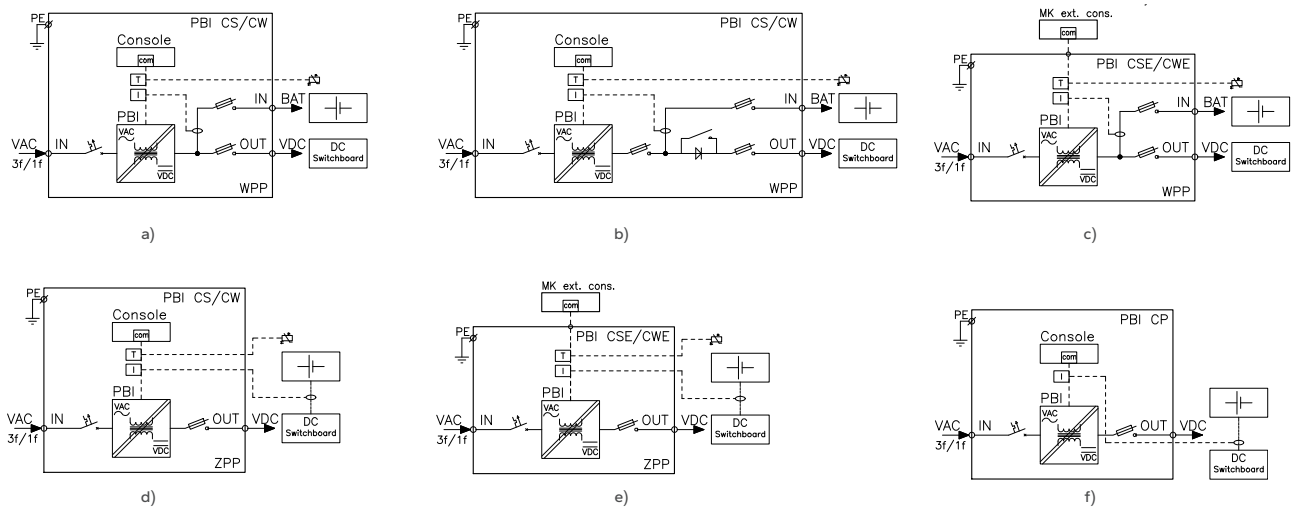


Fig. 16. Block diagram of the PBI type rectifier compact for autonomous operation:
a) a system with WPP; b) a system with WPP and a counter cell; c) a system with WPP and an external MK console;
d) a system with ZPP; e) a system with ZPP and an eternal MK console; f) a portable compact system.

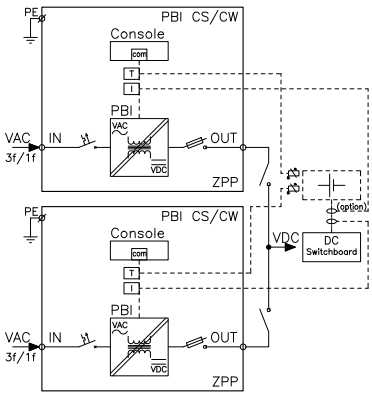


Fig. 17. Block diagram of the PBI type rectifier compact for parallel operation – a system with ZPP.

The PBI rectifier compact is intended for supplying loads in cooperation or without cooperation with the battery.

Compacts with a built-in console are presented in Fig. 16 a), b), d), f), while compacts with an external MK console are presented in Fig. 16 c), e).

The rectifier converts alternating current to direct current of a value according to the order. The galvanic isolation of the rectifier's output voltage from the AC supply voltage of the rectifier is ensured by the high-frequency isolating transformer located in the mains converter.

The devices may operate autonomously (Fig. 16) or in parallel (Fig. 17).

When the rectifier is only used to supply loads with an output DC voltage, this device will be configured without functions related to the battery.

The compact is cooled by a forced air circulation via fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

The PBI CP type rectifier compact is a special case – Fig. 16 f). This is a rectifier usually used for service purposes. By design, it is a portable version of the compact enclosure, having an ejected handles and wheels that ensure comfortable transport. You may set any output voltage in the range from 0 V to the rated value of the power supply. Similarly to the standard battery rectifiers, it features a battery charging thermal compensation and other functions present in the standard version.

SERIES TYPE: RECTIFIER COMPACTS 10 ÷ 350 A FOR AUTONOMOUS AND PARALLEL OPERATION

Rated output current, [A]	DC rated output voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions**
25 / 30 / 50	24	3×400 or 230	PBI 24/25 CS*	CS4 / CW4 / CS7 / CW7
75 / 100			PBI 24/75 CS*	CS4 / CW4 / CS8 / CW8
150		3×400	PBI 24/150 CS*	CS4 / CW4 / CS8
200 / 250 / 300 / 350			PBI 24/200 CS*	CS6 / CW6
25 / 30 / 50	48	3×400 or 230	PBI 48/25 CS*	CS4 / CW4 / CS7 / CW7
75 / 100		3×400	PBI 48/75 CS*	CS4 / CW4 / CS8 / CW8
150			PBI 48/150 CS*	CS6 / CW6 / CS8
25 / 30 / 50	60	3×400 or 230	PBI 60/25 CS*	CS4 / CW4 / CS7 / CW7
75 / 100		3×400	PBI 60/75 CS*	CS4 / CW4 / CS8 / CW8

SERIES TYPE: RECTIFIER COMPACTS 10 ÷ 350 A FOR AUTONOMOUS AND PARALLEL OPERATION – CONTINUED

Rated output current, [A]	DC rated output voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions**
10 / 20 / 25 / 30 / 50	110	3×400	PBI 110/10 CS*	CS4 / CW4 / CS7 / CW7
10 / 20 / 25 / 30 / 50		230	PBI 110/10 CS*	CS4 / CW4 / CS8 / CW8
60 / 75 / 80 / 100		3×400	PBI 110/60 CS*	
10 / 20 / 25 / 30	125	3×400 or 230	PBI 125/10 CS*	CS4 / CW4 / CS7 / CW7
50		3×400	PBI 125/50 CS*	
50		230	PBI 125/50 CS*	CS4 / CW4 / CS8 / CW8
60 / 75 / 80		3×400	PBI 125/60 CS*	
10 / 20	220	3×400 or 230	PBI 220/10 CS*	CS4 / CW4 / CS7 / CW7
25			PBI 220/25 CS*	CS4 / CW4 / CS8 / CW8
30 / 50		3×400	PBI 220/30 CS*	CS4 / CW4 / CS8 / CW8
60 / 75 / 80 / 100			PBI 220/60 CS*	CS6 / CW6
25	400		PBI 400/25 CS*	CS4 / CW4 / CS8 / CW8
50 / 60			PBI 400/50 CS*	CS6 / CW6

* – possible options: CS / CSE / CW / CWE;

** – CS4: 400×(2×600)×250; CS6: 500×(2×700)×250; CS7: 600×(2×600)×300; CS8:600×(2×800)×300; CW4: 400×600×250; CW6: 500×700×250; CW7: 600×600×300; CW8:600×800×300. (W×H×D)

SERIES TYPE: RECTIFIER COMPACTS 10 ÷ 50 A FOR SERVICE OPERATION

Rated current, [A]	DC rated output voltage, [V]	Example type	Enclosure dimensions*
50	from 24 to 220	PBI 24-220/50 CP	CP

* – CP: 400×600×250. (W×H×D).

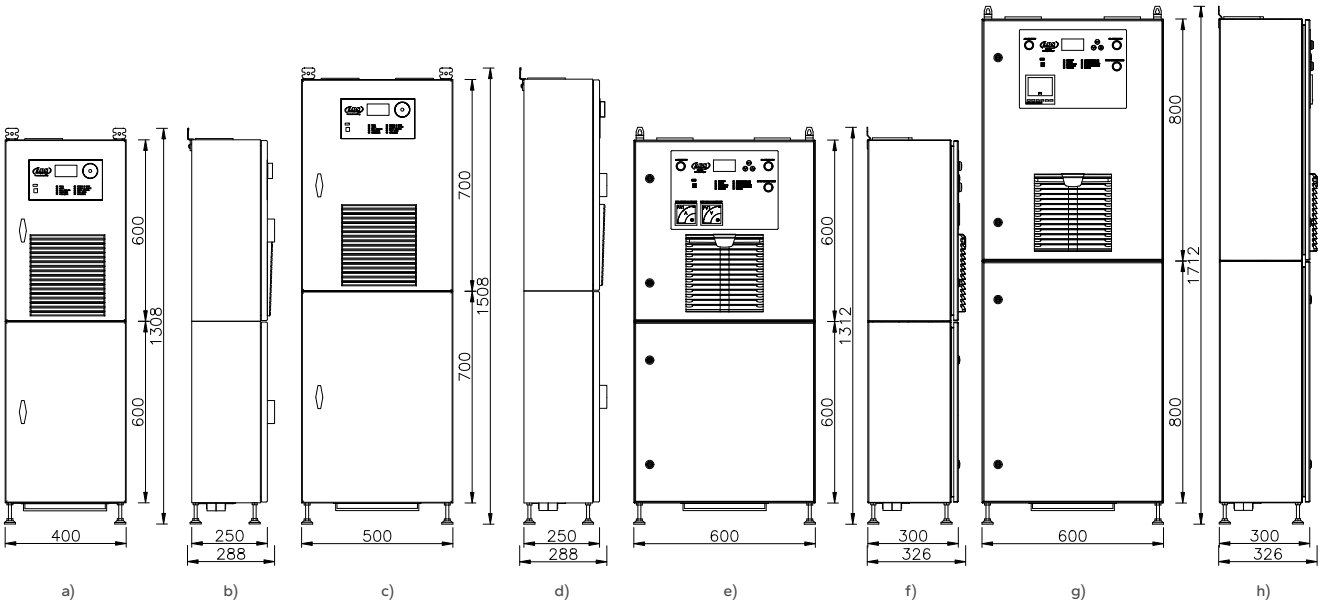


Fig. 18. Views with the dimensions of the PBI type rectifier compact (standing enclosure):
a) CS4 compact – front view; b) CS4 compact – left-side view; c) CS6 compact – front view; d) CS6 compact – front view;
e) CS7 compact – front view; f) CS7 compact – left-side view; g) CS8 compact – front view; h) CS8 compact – left-side view.

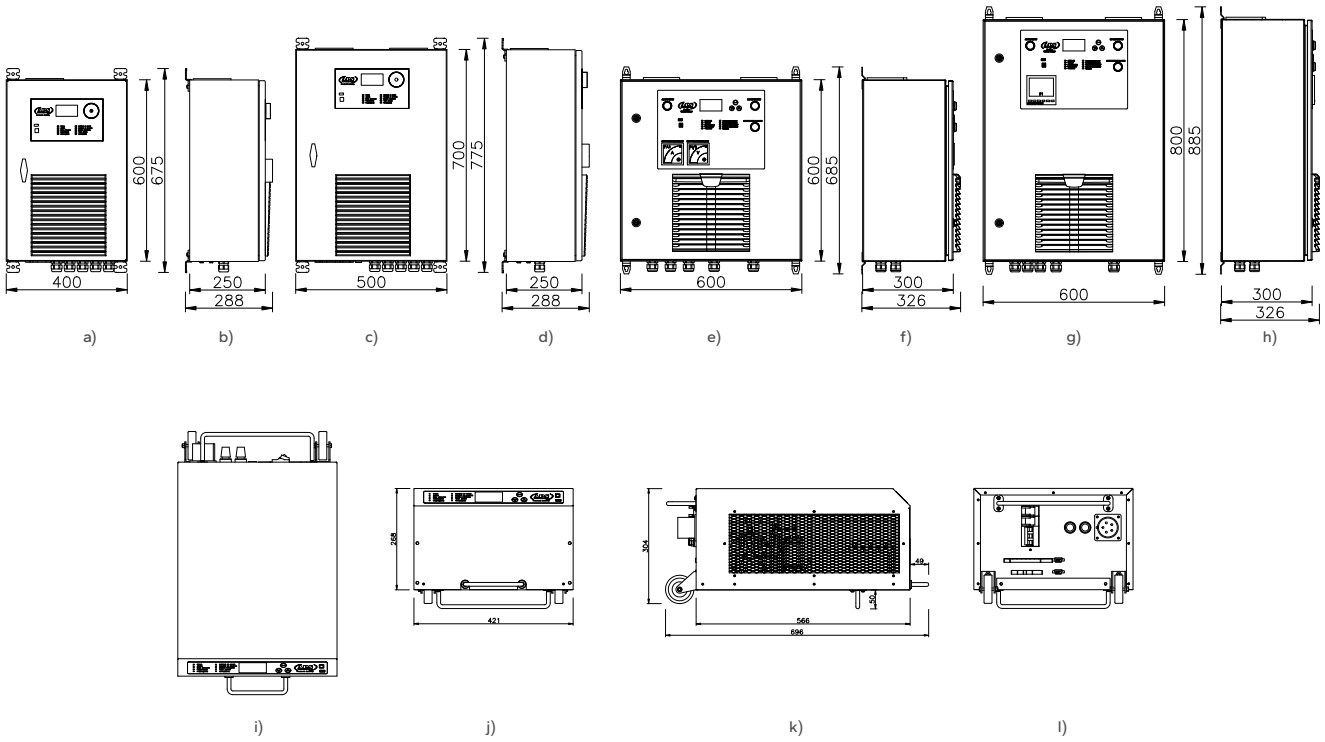


Fig. 19. Views with the dimensions of the PBI type rectifier compact (wall-mounted and portable enclosure):
a) CW4 compact – front view; b) CW4 compact – left-side view; c) CW6 compact – front view; d) CW6 compact – left-side view; e) CW7 compact – front view; f) CW7 compact – left-side view; g) CW8 compact – front view; h) CW8 compact – left-side view; i) CP compact – top view; j) CP compact – front view; k) CP compact – left-side view; l) CP compact – back view.

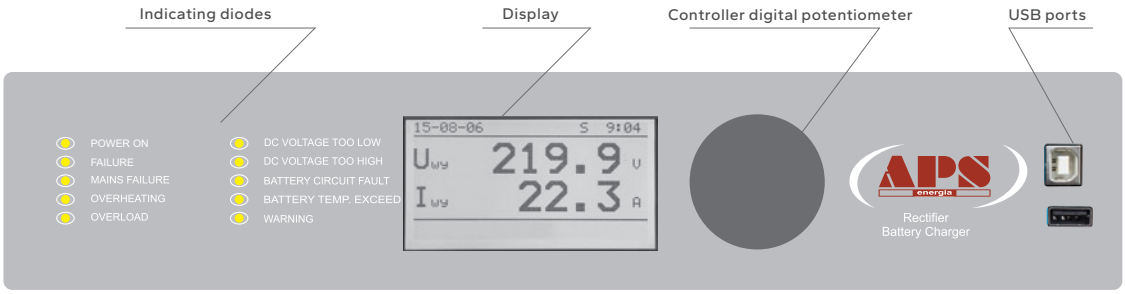
EXTERNAL COMMUNICATION – DIRECT CURRENT SYSTEMS

The rectifiers and DC converters are equipped with an extensive communication system with the user and master systems – HMI (Human Machine Interface).

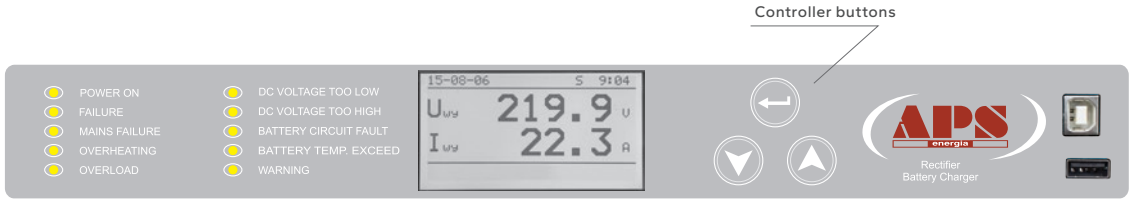
The communication system consists of:

1. A local user panel with an indicator diode system, an LCD screen for displaying messages and reading parameters, and a digital potentiometer or cursors for navigating the console menu.
2. A set of potential-free relay contacts for binary signals.
3. External communication links. Data transmission via RS485, Ethernet and USB ports (reading the archive buffer) is possible.

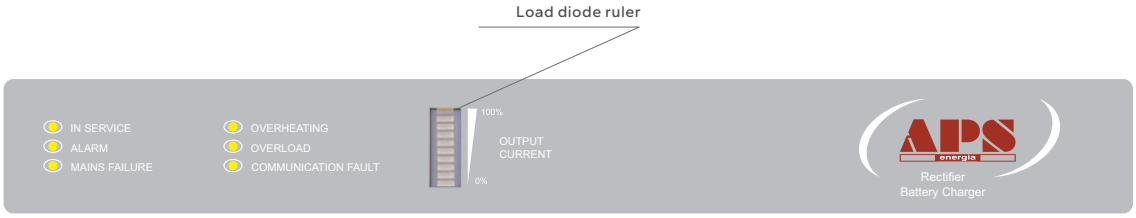
LOCAL USER PANEL



View of the console with a digital potentiometer



View of a console with navigation cursors



View of the console without a display, for modules in multi-module systems and with a separate controller.

SIGNALLED ALARMS ON THE LCD OF THE PBI RECTIFIER

output voltage is too low;	earth fault + warning;
output voltage is too high;	earth fault – warning;
voltage of loads is too low;	earth fault meter error;
voltage of loads is too high;	battery temperature is too high;
deep discharge of the main battery;	battery temperature is too low;
deep discharge of the booster battery;	rectifier temperature is too high;
deep battery discharge;	module failure;
module power supply failure;	failure;
power supply failure;	module overheating;
no power supply to the module;	overheat;
no power supply;	overload;
battery circuit discontinuity;	no communication;
damage of the battery temperature sensor;	fan fault;
earth fault + alarm;	no parallel communication;
earth fault – alarm;	XIN fuse tripping.

THE PBI RECTIFIER'S MEASURED PARAMETERS

output voltage;
battery current;
rectifier current;
battery temperature.

PARAMETERS MEASURED FOR THE "SELF-TEST" FUNCTION OF THE PBI RECTIFIER

by carrying out the self-test, the user obtains information about the internal and intermediate parameters responsible for proper operation of the device, such as:
current measurement transducers internal supply voltage;
processors supply voltages;
compliance of the measurements with the measurement range.

INTEGRATED RS485, USB, ETHERNET COMMUNICATION INTERFACES

RS485 LINK

RS485 is wired interface used in industrial networks. The basic advantage of data transmission via the RS485 bus bar is resistance to external distortions (e.g., of induction equipment, such as motors). The RS485 standard allows to connect many transmitters and loads (up to 32). The range of this standard is approx. 1,200 m.

The RS485 link of the rectifier features APS6000, Modbus RTU, IEC 60870-5-103 transmission protocols. They allow reading a complete set of data from the device.

By use of an external converter, it is possible to transmit data in the Profibus DP protocol and other protocols.

USB LINK

In the APS devices, the USB link is used to copy archive buffers saved during operation.

The USB port (A) is used to connect mass memory (USB flash drive).

The USB port (B) operating in the mass memory mode (mass storage device); after connecting it to a PC, it is shown as an additional drive.

ETHERNET LINK

Ethernet (IEEE 802.3) is the most commonly used technology in local networks (LAN). This interface allows connecting the device to a local computer network in the facility, and thus easily reading data even from several stations at the same time.

The Ethernet interface may be implemented by application of an additional converter, ensuring transmission using one of the following protocols:

- IEC 61850 (APS SAN KP1 converter)
- SNMP (AGENT- APS2)
- Modbus TCP.

Storage of events and states of the operation of the device on an SD card

A 2GB internal memory card stores data stored in the events buffer and the archive buffer. Lack of a card makes saving logs impossible and is indicated on the display by "SD" symbol.

Copying data to a FLASH memory stick:

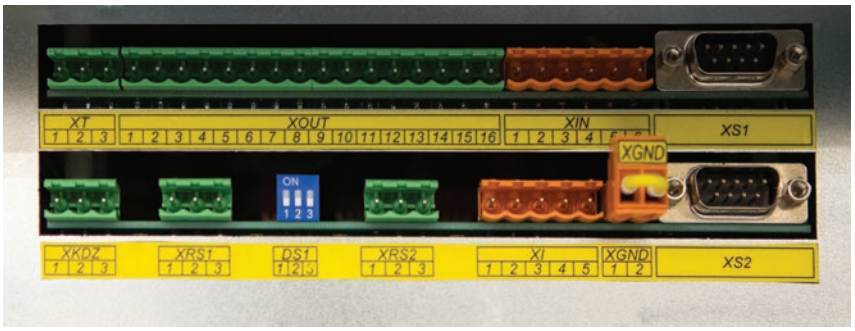
USB 2.0 ports enable communication between the power supply and the computer system or transferring alarm logs to a FLASH portable memory (USB flash drive).

The USB type port (B) sends archive data directly to a PC

The USB type port (A)

THE PBI RECTIFIER BINARY SIGNALS

INPUT BINARY SIGNALS:	OUTPUT BINARY SIGNALS:
charging interlock	general alarm 1
rectifier operation interlock	general alarm 2 (configurable)
fuse tripping	no power supply
DC +24 V auxiliary supply	output voltage is too high
	output voltage is too low
	battery circuit discontinuity
	correct operation
	alarm 8 (configurable)
	earth fault (option)



Connection panel of the PBI MC type rectifier

THYRISTOR RECTIFIERS

The PBI T systems are designed in a way to meet strict quality standards and reliability criteria for operation in difficult operating conditions, including the requirements related to operation of devices in nuclear plants. The topology of the PBI T rectifier allows designing rectifiers of high output power. The power supply is equipped with 12-pulse or 6-pulse thyristor rectifier with a transformer. The rectifier draws current of characteristics similar to a sinusoid from the mains (in 12-pulse version – lob content of THDi disruptions).

THE PBI T TYPE THYRISTOR RECTIFIER CHARACTERISTICS:

- IGBT technology with a DSP microprocessor controller;
- three operation modes (buffer, automatic, manual);
- high stability of voltages and output currents;
- charging algorithm (as per DIN 41773), for various types of batteries;
- low level of current ripple and voltage on the output;
- battery current control;
- battery temperature control;
- integrated communication RS485, USB interfaces;
- wide selection of external communication protocols: Modbus RTU, IEC 60870-5-103. Type of the protocol selected in the control menu panel;
- electromagnetic compatibility (EMI filters);
- option of parallel operation of the rectifiers;
- galvanic isolation from the mains;
- archiving of events and operating states (SD card);
- anti-seismic design;
- natural (convection) or forced (fans) cooling.

Views of the PBI T type thyristor rectifier's cabinet

DESCRIPTION OF OPERATION OF THE PBI T RECTIFIER

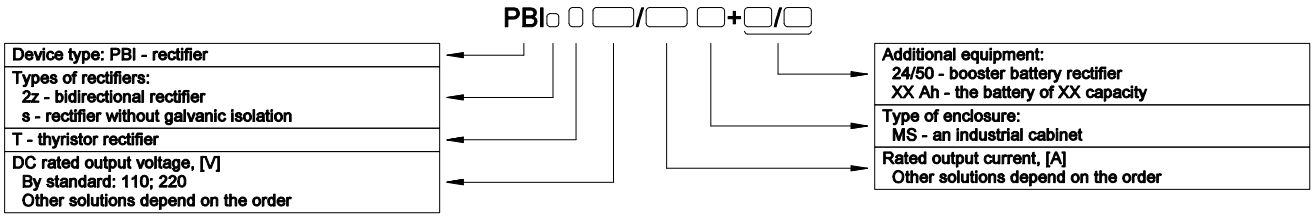
Buffer operation	The device supplies the battery and/or loads with voltage of high degree of stability and the required value (most often 2.23 V/cell). The buffering voltage is compensated thermally by a thermal probe (positioned in the vicinity of the supplied battery) present in the standard equipment. The output voltage of the power supply adapts itself to the needs of the battery, maintaining the fully charged state. During buffer operation, the continuity of the battery's circuit is cyclically checked.
Automatic charging (automatic mode)	This function is used in the case of partial or complete discharge of the battery (e.g., as a result of supply voltage break), when the battery must be quickly charged. The power supply will automatically charge the battery to 2.4 V/cell.
Supervised charging (manual mode)	This mode is used in the case of cooperation with open acid batteries, when there is a need to carry out an additional equalising charging to 2.7 V/cell. This charging process must be carried out strictly according to the guidelines of the manufacturer of the battery and always in the presence of the operating personnel.

OPERATION MODES PARAMETERS

Factory settings

Operation mode	Lead-acid batteries	Ni-Cd batteries	Adjustment range
Buffer mode (Float mode)	2.23 V/cell	1.41V/cell	0.8–2.4 V/cell
Automatic charging (Boost mode)	2.40 V/cell	1.50 V/cell	0.8–2.7 V/cell
Supervised charging (Equalising mode)	2.70 V/cell	1.80 V/cell	0.8–2.7 V/cell

METHOD OF DESIGNATION OF THE PBI T TYPE THYRISTOR RECTIFIERS



THE PBI T TYPE THYRISTOR RECTIFIERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE
AC INPUT*	
Three-phase input voltage	380 / 400 / 415 V
Input voltage tolerance	-15 % to +10 % (±15 % for 380 V)
Frequency of input voltage	50 / 60 Hz
Input voltage frequency tolerance	±8 %
DC OUTPUT	
Output voltage	110 / 220 V*
Output voltage stability**	±1 %
Output voltage ripple****	±2 %
Range of correction of the buffer charging voltage	between -10 and +50 °C
Temperature compensation of the buffer charging voltage**	0 to 10 mV/°C/cell
Rated output current	25 to 1,500 A
Overload capacity	1,2×In for 5 sec
Output current stability***	±1 %
Output current ripple***	±2 %
Battery charging characteristics	IU as per DIN 41773
Total efficiency	>91 % for 110 V; >93 % for 220 V
Available menu language versions	PL | EN | CZ | RU
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front*
Cable entry	from the bottom / from the top*****
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;
** – buffer operation, voltage regulator;
*** – battery charging, current regulator;
**** – at resistance load;
***** – only for installation in an industrial cabinet (MS enclosure type).

THREE-STAGE I_1 U_1 U_2 BATTERY CHARGING TECHNIQUE

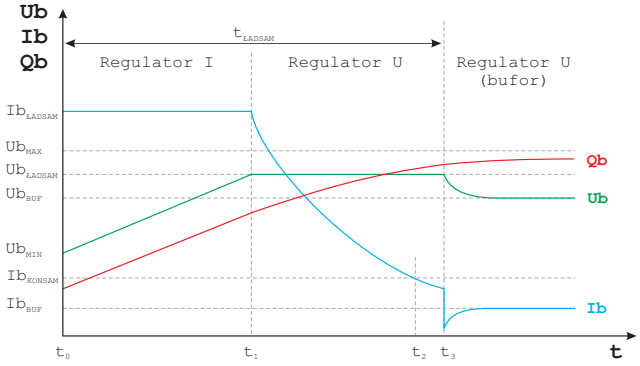
In the case of discharge of the battery, the PBI rectifier will automatically activate the quick charging mode. The charging parameters are configured in the memory of the rectifier in accordance with the requirements of the producer of the battery of a given type. The charging has three stages:

- 1st phase – direct current charging I_1 (the first limit parameter): This charging includes limitation of the battery charging current na; the rectifier gradually increases the battery voltage to not exceed the recommended charging current (most often, limitation at the level of current I_1 = 5 to 10-hour charging (I_{C10}));
- 2nd phase – direct current charging U_1 (the second limit parameter): The battery is partially charged after the first phase of charging, there is no risk that the increase of the charging voltage will exceed the set battery current I_1, the second limit parameter works, the allowed (maximum voltage at the DC bus due to loads or due to the battery) voltage U_1. Completion of the 2nd phase of charging depends on the adopted algorithm. APS Energia SA uses the DBC method.
- 3rd phase – direct current charging U_2; the system has completed quick charging, and the rectifier switches to voltage U_2 = Ubuf buffer voltage.

The DBC is a charging method developed by APS Energia SA based on the experienced in production of buffer rectifiers and in strict cooperation with the manufacturers and users of batteries. The Dynamic Battery Charging (DBC) is a method which controls all charging parameters, and thus ensures quick replenishment of the battery's electric charge according to all recommendations of the producer of a given type of cell. The method consists of charging of the battery with voltage U1 in the second phase until the two following criteria are met at the same time:

- Criterion no. 1 – achievement of the set value (e.g., $0.2 \times I_{C10}$) by the dropping charging current – a configurable parameter;
- Criterion no. 2 – charging of the battery after the criterion no. 1 has been met for 30 minutes – a configurable parameter.

CHARGING CHARACTERISTICS



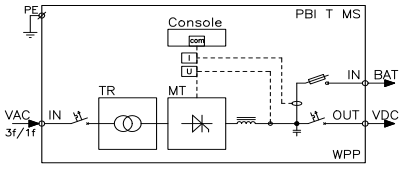
DBC model (*Dynamic Charge Characteristic*)

Configurable parameters:

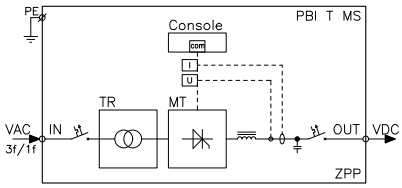
- charging current – Ib_{C10}
- maximum voltage – Ub_{MAX},
- recharge current – Ib_{DOL},
- automatic charging time – T_2.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BAT – battery	OUT – output
I – current measurement	TR – transformer
IN – power supply	VAC – alternating current (AC)
com – communication	VDC – direct current (DC)
MT – thyristor bridge	



a)



b)

Fig. 20. Block diagram of the PBI T type thyristor rectifier's cabinet:
a) a system with WPP; b) a system with ZPP

Fig. 20 presents a standard solution of the PBI T MS type thyristor rectifiers for free incorporation in the industrial cabinet. These systems are intended for supplying loads in cooperation or without cooperation with the battery. The functionality of the PBI T MS systems allows designing rectifiers of significant output power.
The thyristor rectifier converts alternating current to direct current of value according to the order. The galvanic isolation of the rectifier's output voltage from the AC supply voltage of the rectifier is ensured by the 50 Hz isolating transformer.

When the rectifier is only used to supply loads with an output DC voltage, this device will be configured without battery functions.
The industrial cabinet is cooled naturally or by a forced air circulation via fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

DESCRIPTION OF THE PBI T TYPE THYRISTOR RECTIFIER

Battery current measurement

The system measures the battery circuit current using a transducer. The transducer may be located inside the power supply (internal current measurement) or outside the power supply (external current measurement), e.g., in the user's distribution board or at the battery itself, on any pole.

Battery circuit continuity test

In the buffer operation state, the rectifier cyclically tests the continuity of the battery's circuit. The rectifier carries out the test by appropriately adjusting the voltage and measuring the current. After a positive test result, the rectifier's voltage goes back to the buffer voltage level. The test parameters are set in the rectifier's menu.

Charging interlock

Switching the rectifier into the "charging interlock" mode limits the current flowing to the battery at the 100-hour current level. This function is tripped by applying signal to the binary input. The charging interlock limits the current during the automatic charging and supervised charging.

Rectifier operation interlock

In this mode, the rectifier does not transfer energy from the mains to the loads and the battery, and only remains in the standby mode. The rectifier will start automatically after the "rectifier interlock" signal has been removed. This function is tripped by applying signal to the binary input.

Over-voltage protection of the load
When a voltage dangerous to loads is present for a time longer than 500 ms at the power supply's output, an over-current protection is activated to turn the rectifier off. This voltage is preset appropriately to the rated voltage of the power supply. After the excessively high voltage at the input ceases, the rectifier restarts.

Hysteresis of the power supply's alarm thresholds
All of the set alarm thresholds have a hysteresis that "deadens" the system at the limit of alarm tripping.

Battery voltage thermal compensation
The battery's buffer voltage changes with the temperature fluctuations. In accordance with the recommendations of the battery manufacturers, the battery's charging voltage thermal compensation is applied. The rectifier may carry out a procedure of automatic temperature compensation to adapt the battery's voltage to the environmental conditions.

Limitation of the battery charging current
The rectifier limits the battery's charging current to the value set by the user and expressed by the time in which we want to charge the battery. During the supervised charging, the current is limited to the value set by the personnel when configuring the supervised charging parameters.

Control of the resistance of the earth fault insulation of the SAN 2-0
The rectifier may be equipped with a microprocessor system that controls the SAN 2-0 earth fault. The earth fault control system is intended for measuring the value of the insulation resistance in the direct current installation circuits (the battery's poles ground faults control). The device measures and signals a drop of the symmetrical and asymmetrical resistance. A drop of the value of resistance below the warning or alarm threshold is signalled in the status of the device and trips relevant alarm relays.

Auto-restart
The PBI rectifiers are equipped with an auto-restart function when the power supply voltage appears, if a power supply voltage break caused the rectifier to turn off.

Data archiving
The events buffer is an area in the permanent memory of the rectifier, in which all alarm events, including date and time, are saved.

The archive buffer is an area of the permanent memory of the rectifier, in which measurement series are stored with an interval set by the user.

USB 2.0 ports enable communication between the power supply and the computer system or transferring alarm logs to a FLASH portable memory (USB flash drive).

Communication with the user
Communication between the user and the device (HMI, Human Machine Interface) may take place both locally and remotely.

Locally, using the console (keyboard, LCD, indicating diodes), located on the front side of the device. Electrical parameters are displayed constantly, regardless of the selected operation mode. Alarm states are indicated using diodes and the display. Additionally, a sound signal is generated, which informs about an emergency situation.

Remotely, using the binary inputs and outputs, as well as communication ports.

You may assign different functions to the binary inputs to change the operation of the rectifier (via the rectifier's menu).

RS485, USB, LAN transmission communication ports.

Available transmission protocols:

- selected from the controller's menu: APS6000, Modbus RTU, IEC 60870-5-103;
- available with the converter: IEC 61850, PROFIBUS DP, SNMP, Modbus TCP.

THE PBI T TYPE THYRISTOR RECTIFIER EQUIPMENT

POWER SUPPLY SYSTEM:

12-pulse transformer,

Two 6-pulse thyristor bridges,

DSP microprocessor controller (DC-DEV):

- Control of the pulse converter;
- Monitoring functions;
  - selection of the operating mode (automatic charging or buffer operation);
  - correction of the voltage value depending on the battery's temperature;
  - limitation of the battery's charging current to the set value;
  - generation of alarm signals;
- Local communication – issues and receives signals from the user's console;
- Communication with external monitoring systems via RS and Ethernet links.

Console (AR-CON)
It consists of an LCD, LED synoptic, and a three-button keyboard or a digital potentiometer. The console provides information about the state of the battery and operation of the rectifier, as well as allows making changes in the power supply settings.

Connection terminal
It consists of connections of power and output lines appropriate for the designed current and the projected wiring.

Protection fields
Includes over-current and over-voltage protections.

Analogue meters
Used to measure currents and output voltages in the first precision class.

Binary signals terminal
The PBI T rectifier is equipped with binary inputs and outputs, as well as auxiliary voltage sources to apply signals to those inputs. Potential-free contacts transfer binary information about the state of the device, operating conditions, and alarms. You may assign different functions to the binary inputs to change the operation of the inverter and the rectifier. The rectifier is equipped with two binary inputs.

Enclosure
The industrial cabinet of 600 mm or 800 mm width (or its multiple depending on the power). The structure of the cabinets is welded and protected against corrosion with metallic coatings and powder coating.

The battery current measurement system measures the battery's circuit current using the transducer on the pole of the battery's circuit.

INTERNAL PROTECTION AGAINST:

- increase of the voltage on the input;
- drop of the voltage on the input;
- supplying the rectifier with asymmetrical voltage;
- overheating of power systems (limitation of the output current without interrupting operation);
- increase of voltage on the thyristors;
- power surges caused by dynamic changes of the load;
- internal short-circuits;
- short-circuits at the loads;
- increase of the voltage on the output;
- excessive input ripple;

COOLING SYSTEM
Cooling air flows through the air intake in the lower part of the enclosure, and then via convection flows towards the upper part of the device, cooling the internal elements of the rectifier. Hot air flows out of the device through vents located at the top of the enclosure.

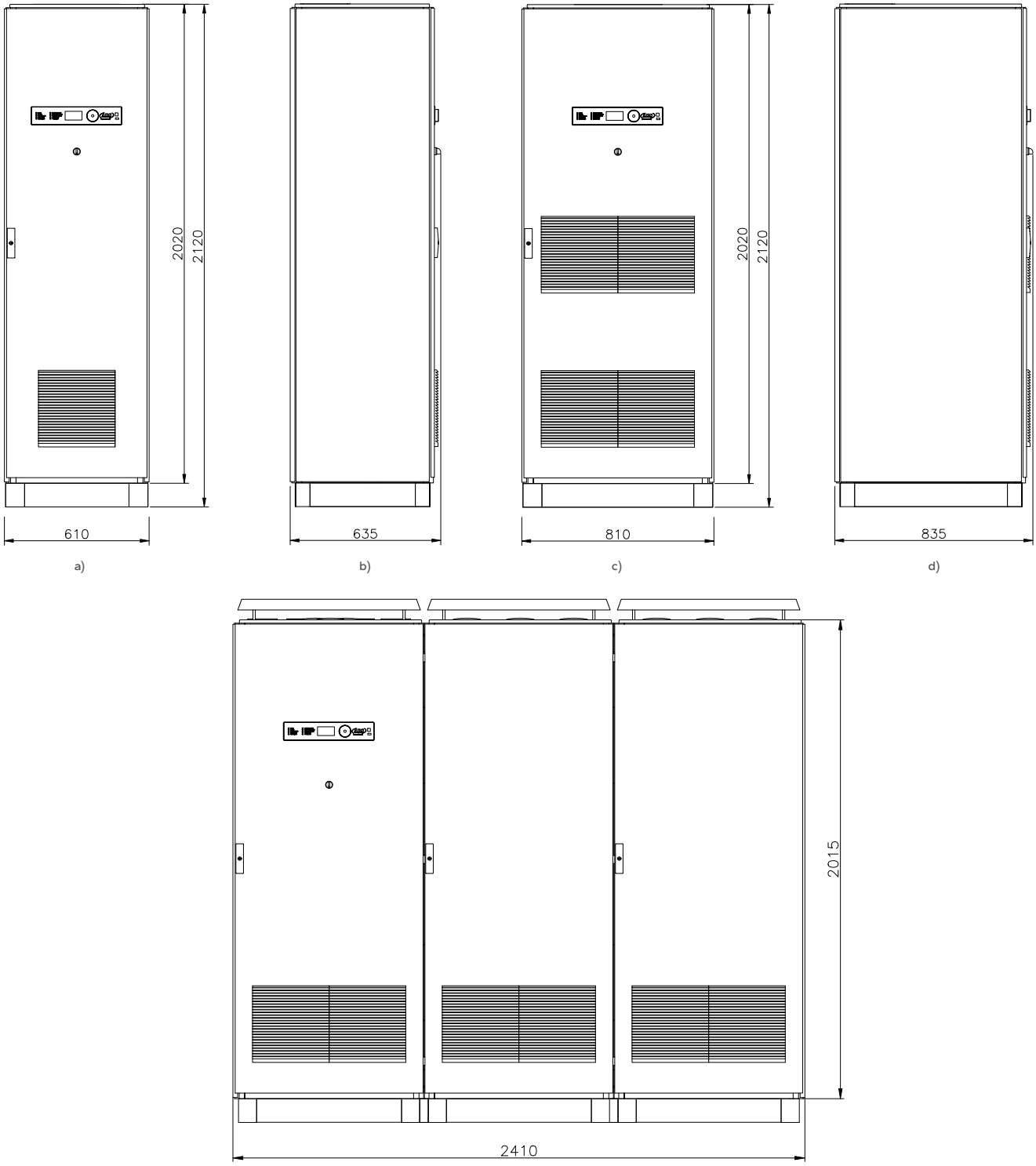
ADDITIONAL OPTIONAL EQUIPMENT FOR THE PBI T THYRISTOR RECTIFIERS

Special designs	Upon request, it is possible to adapt the devices to special requirements in relation to: • greater DC rated currents; • standard of voltages and frequencies of AC power supply: (110 / 190 V, 115 / 200 V, 120 / 208V, 127/220 V, 50 / 60 Hz); • level of the DC output voltages; • extension of the range of input voltages; • environmental requirements related to ambient temperature (-20 °C ÷ +55 °C), presence of aggressive factors, etc.; • enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.; • measurements and communication: digital or analogue meters of appropriate class, indication of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.
ATSE system	The automatic transfer switching equipment (ATSE) decides about the selection of the source of power for a device. During presence of the voltage of the source no. 1, the rectifier is supplied by it. In the case of break (complete or one of the phases of the source no. 1), the ATSE automatically switches supply of the rectifier to the source no. 2.
Automatic load disconnection	The PBI T rectifier may be equipped with a contactor that disconnects loads when the battery's voltage drops below the value set by the "load disconnection" parameter. The loads will remain disconnected until the rectifier's voltage reaches the level above the "connection of loads" parameter.
Parallel operation of rectifiers	This option provides equal output currents of rectifiers that generate common load. It is possible for two PBI T type rectifiers to operate in parallel.
Booster battery connecting system	The PBI T rectifiers may be equipped with a booster battery connecting system in a series with the main battery. Connection takes place without interruptions (from the point of view of loads). The booster battery is connected after the voltage of the main battery drops to the specified level, and is disconnected when the voltage of the main battery increases. tripping and disconnection take place automatically. The booster battery may be connected to the positive or negative pole of the main battery (depending on the design).
Counter cell system	The counter cell consists of diodes connected in series and bypassed by the contactor's pin. This is a system that allows lowering of voltage in DC loads. Voltage on the load bus is reduced by activation of the serial diode stack at the output of the loads. When the battery's voltage drops (e.g., when the rectifier turns off), the contactor closes the shunt circuit, and the diode stack is bypassed. The voltage of loads is equal to the voltage of the battery. The counter cell system may be controlled based on the power supply voltage break or drop of the battery's voltage.
Cable entry from the top	It is possible to design the enclosure in a way to allow cables entering from the top.

SERIES TYPE: THYRISTOR RECTIFIER CABINETS 50 ÷ 1500 A FOR AUTONOMOUS AND PARALLEL OPERATION

Rated output current, [A]	DC rated output voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H*], [mm]
100	110	3×400	PBI T 110 / 100 MS	600×600×2,000
200			PBI T 110 / 200 MS	
300			PBI T 110/300 MS	800×800×2,000
400			PBI T 110 / 400 MS	
500			PBI T 110/500 MS	
600			PBI T 110 / 600 MS	1,400×800×2,000
800			PBI T 110/800 MS	
1,000			PBI T 110 / 1000 MS	
1,200			PBI T 110 / 1200 MS	1,800×800×2,000
1,500			PBI T 110 / 1500 MS	
50	220		PBI T 220/50 MS	600×600×2,000
100			PBI T 220 / 100 MS	
200			PBI T 220 / 200 MS	800×800×2,000
300			PBI T 220/300 MS	
400			PBI T 220 / 400 MS	
500			PBI T 220/500 MS	1,600×800×2,000
600			PBI T 220 / 600 MS	
800			PBI T 220/800 MS	
1,000			PBI T 220 / 1000 MS	1,800×800×2,000
1,200			PBI T 220 / 1200 MS	
1,500			PBI T 220 / 1500 MS	2,400×800×2,000

* – add the height of the pedestal to the height of the device: by standard, 100 mm.



a) b) c) d)

e)

Fig. 21. Views with the dimensions of the PBI T type thyristor rectifier cabinet:
a) 600×800×2,000 cabinet – front view; b) cabinet of depth of 600 mm – left-side view;
c) 800×800×2,000 cabinet – front view; d) cabinet of depth of 800 mm – left-side view;
e) examples of a cabinet of width of 2,400 mm – front view.

DIRECT CURRENT CONVERTERS

The EPI type DC/DC converters are intended for conversion of DC voltage to a stabilised DC voltage required by the loads – in the range from 24 to 220 VDC or other loads that meet the specification.

CHARACTERISTICS OF THE EPI TYPE DIRECT CURRENT CONVERTER:

- high stability of voltages and output currents;
- very low current ripple and output voltage;
- modular design;
- compact dimensions and low weight;
- silent operation;
- high efficiency;
- optional design with a galvanic insulation or without a galvanic insulation;
- electromagnetic compatibility (EMI filters);
- control of the earth fault on both output poles;
- the user interface (HMI – Human Machine Interface), the control console with diode signalling and an LCD, potential-free outputs, RS485, USB communication ports, data archiving.

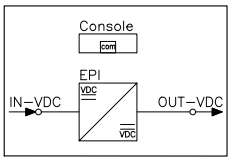


Fig. 22. General block diagram of the DC/DC converter system

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

EPI/EPIs – DC/DC converter	com – communication
I – current measurement	OUT – output
IN – power supply	VDC – direct current (DC)

Views of the rectifier module

Views of the rectifier compact

Views of the rectifier cabinet

METHOD OF DESIGNATION OF THE EPI TYPE DIRECT CURRENT CONVERTERS

EPI□ □/□/□ □

Device type: EPI - direct current converter with galvanic isolation	Type of enclosure: M - 19" module without controller MC - 19" module with mounted controller MCE - 19" module with an external console MS - an industrial cabinet CS - standing compact CSE - standing compact with an external console CW - wall-mounted compact CWE - wall-mounted compact with an external console
Types of rectifiers: s - converter without galvanic isolation	
DC rated input voltage, [V] By standard: 24; 48; 60; 110; 220 Other solutions depend on the order	
DC rated output voltage, [V] By standard: 24; 48; 60; 110; 220 Other solutions depend on the order	Rated output current, [A] Other solutions depend on the order

THE EPI/EPIs TYPE DC/DC CONVERTERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE
DC INPUT	
Input voltage:	24 / 48 / 60 / 110 / 220 V
Input voltage tolerance	-15 % to 40 %*
DC OUTPUT	
Output voltage:	24 / 48 / 60 / 110 / 220
Output voltage stability	±0.6 %
Output voltage ripple**	±0.6 %
Rated output current	10 to 1,500 A
Overload capacity	1,5×In for 2 sec
Output current stability	±1 %
Output current ripple	±1 %
Total efficiency	>92 %
Available menu language versions	PL | EN | CZ | RU
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front*
Cable entry	from the bottom / from the top***
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;

** – at resistance load;

*** – only for installation in the industrial cabinet (MS enclosure type).

DC/DC CONVERTERS WITH GALVANIC INSULATION

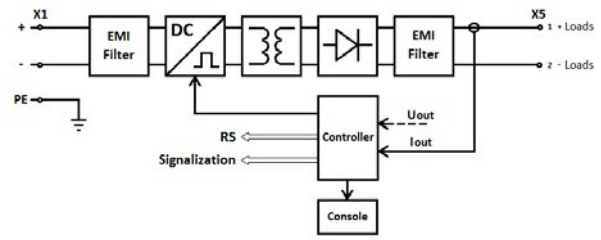


Fig. 23. Conceptual diagram of the converter with the EPI type galvanic insulation

This type of converters are constructed with the use of IGBT transistors, and operate using the Pulse Width Modulation (PWM). Direct supply current is converted in a two-stage system of converters.

- high-frequency converter,
- high-frequency rectifier.

The EPI converter is equipped with a DSP (Digital Signal Processor) microprocessor control system, which controls the operation of the converter.

The Pulse Width Modulation (PWM) converter ensures adaptation of the input voltage value to the needs of the loads. The high-frequency ferrite transformer provides a galvanic insulation for the input and output circuits.

DC/DC CONVERTERS WITHOUT GALVANIC INSULATION

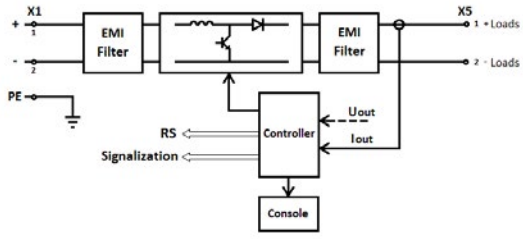


Fig. 24. Conceptual diagram of the converter without the EPIs type galvanic insulation

This type of converter is designed using a transistor converter, but without a high-frequency transformer, and there is no galvanic insulation in the DC/DC voltages circuit. The EPIs converter is used in systems as a stabiliser of voltages of loads at deep discharge of the battery. A significant advantage of the system is the lack of limitation of the current in the case of short-circuit in the loads. In such a case, the current from the battery (power supply) flowing through a gland and a diode may trip protection in the circuit in which a short-circuit occurred. An additional advantage is the converter's topology, which ensures supplying loads directly from the battery, even if it gets damaged. The EPIs type converter is unable to lower the input voltage for the needs of the loads (it may only increase them).

SPECIAL DESIGNS OR EQUIPMENT OPTIONS FOR THE DC/DC CONVERTERS

Upon request, it is possible to adapt the devices to special requirements of a given project in relation to:

- greater DC rated currents;
- other rated DC voltages;
- extension of the range of DC input voltages;
- environmental requirements related to ambient temperature (-20 °C to +55 °C), presence of aggressive factors, etc.;
- enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.;
- measurements and communication: digital or analogue meters of appropriate class, signalling of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.;
- cable entry from the top

APPLICATION OF THE EPI SYSTEMS:

DC/DC CONVERTERS

- To ensure additional direct current for systems of voltage other than the battery's voltage.
- To ensure stable voltage for DC power supply for critical loads. These loads must not be directly connected to the battery which is charged with buffer power supply changing in the temperature function during operation.

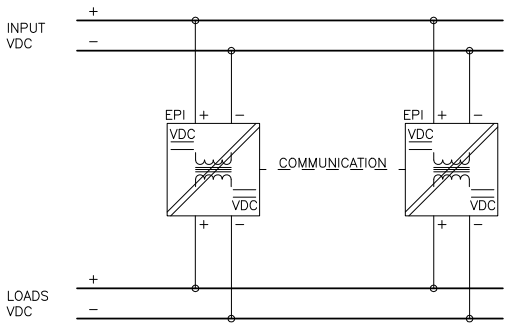


Fig. 25. DC/DC converter connection diagram – a redundant system

DC/DC CONVERTERS – ATSE DC

A special type of application of DC/DC converters is a power supply system from two galvanically insulated DC sources. DC supply fields may also have different voltages. In the case of parallel operation, the system is redundant. In the case of autonomous operation of the converters, using output voltage, you may obtain a system with a preferred power source, with a function to switch to a reserve power supply in the case of its interruption (ATSE DC system).

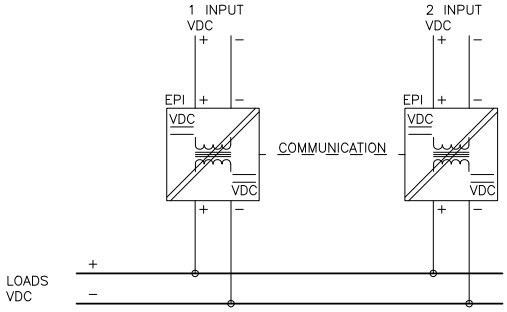


Fig. 26. DC/DC converter connection diagram – ATSE DC

DESCRIPTION OF FUNCTIONS OF THE EPI CONVERTER

Converter operation interlock	Switching the converter into the "operation interlock" mode causes voltage break on the converter's output. In this mode, the converter does not transfer energy from the mains and remains in the standby mode. The converter will start automatically after the "operation interlock" signal has been removed. This function is tripped by applying voltage to the binary input. This function is necessary if the converter must be controlled remotely.
Protection of loads against excessively high voltage	When a voltage dangerous to loads is present for a time longer than 500 ms at the converter's output, an overcurrent protection is activated to turn the converter off. This voltage is preset appropriately to the rated voltage of the converter. After the excessively high voltage at the input ceases, the converter restarts.
Hysteresis of the converter's alarm thresholds	All of the set alarm thresholds have a hysteresis that "deadens" the system at the limit of alarm tripping.
Control of the earth fault of the output poles	The earth fault control system is intended for measuring the value of the insulation resistance in the direct current installation circuits (the converter's poles grounding control). The device measures and signals a drop of the symmetrical and asymmetrical resistance. The LCD continuously displays the resistance of the insulation of both poles towards the earth fault (an additional screen in the grounding control screen). A drop of the value of resistance below the warning or alarm threshold is signalled in the device's "Current events" menu and trips appropriate alarm relays.
Parallel operation of converters	During operation on the common load bus, all the EPI type converters automatically and evenly distribute the load between each other by equalising the output currents.
Fans operation control	The fans installed in the modules are equipped with damage sensors. Stoppage of the fans is signalled by illumination of the "warning" diode on the converter's console. Information about the damage is stored in the event buffer. There is a possibility to signal such a state using relay outputs.
Data archiving	The events buffer is an area in the permanent memory of the converter, in which all alarm events, including date and time, are saved. The archive buffer is an area of the permanent memory of the converter, in which measurement series are stored with an interval set by the user. USB 2.0 ports enable communication between the power supply and the computer system or transferring alarm logs to a FLASH portable memory (USB flash drive).
Controlling operation of the roof fans	The MS versions of the EPI converter allows controlling operation of the roof fans. The roof fans (which extract air from inside the cabinet) may work in two speeds. Application of power supply starts the fans at the 1st speed. When the temperature inside the cabinet exceeds the 2nd speed tripping threshold of the roof fans, their efficiency of extraction of hot air from inside the cabinet will increase.
Communication with the user	Communication between the user and the device may take place both locally and remotely. Locally, using the console (keyboard, LCD, indicating diodes), located on the front side of the device. Electrical parameters are displayed constantly, regardless of selected operation mode of the panel. Alarm states are indicated using glowing diodes and the display. Additionally, a sound signal is generated, which informs about an alarm state (the sound signaller is located behind the panel's board). Remotely, using the binary inputs and outputs, as well as communication ports. You may assign different functions to the binary inputs to change the operation of the converter. The functions are assigned in the converter's menu. The transmission communication ports (RS485, USB) allow connecting multiple transmitters and loads. The following transmission protocols are available at the rectifier's connections: Selected from the controller's menu: APS6000, Modbus RTU, IEC 60870-5-103. Available with the converter: IEC 61850, PROFIBUS DP, SNMP, Modbus TCP. They allow to read the full set of data from the rectifier.
Self-test	Thanks to the "self-test" function, the user obtains information about correctness of internal and intermediate parameters responsible for proper operation of the device.

MODULAR DESIGN CONVERTERS

This chapter presents the EPI/EPIs type DC/DC converters in a form of a 19" module. They are adapted for mounting in industrial cabinets. The main task of a DC/DC converter is to continuously supply loads with DC guaranteed voltage.

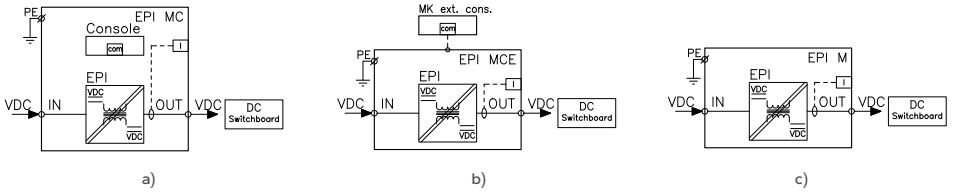


Fig. 27. Block diagram of the converter module with the EPI type galvanic insulation for autonomous operation:
a) with a built-in console; b) with an external MK console; c) without a console.

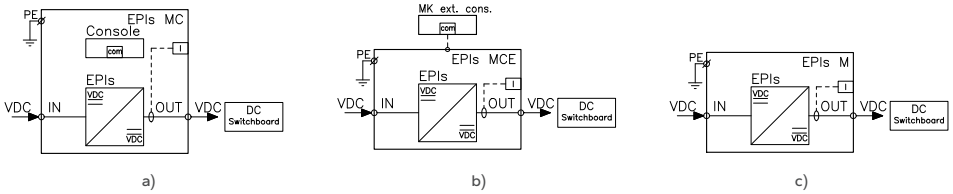


Fig. 28. Block diagram of the converter module without the EPIs type insulation for autonomous operation:
a) with a built-in console; b) with an external MK console; c) without a console.

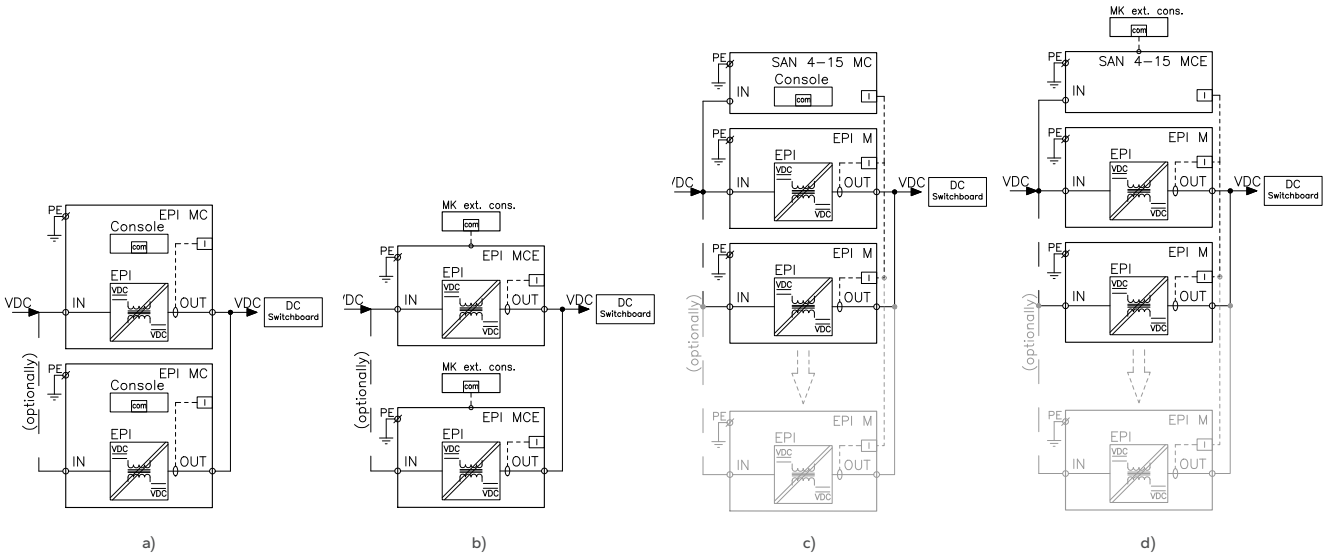


Fig. 29. Block diagram of the converter modules with the EPI type galvanic insulation for parallel operation:
a) the EPI MC type modules system; b) the EPI MCE type modules system with an external MK console;
c) the EPI M type modules and the SAN 4-15 MC type controller system; d) the EPI M type modules and the SAN 4-15 MCE type controller system with an external MK console.

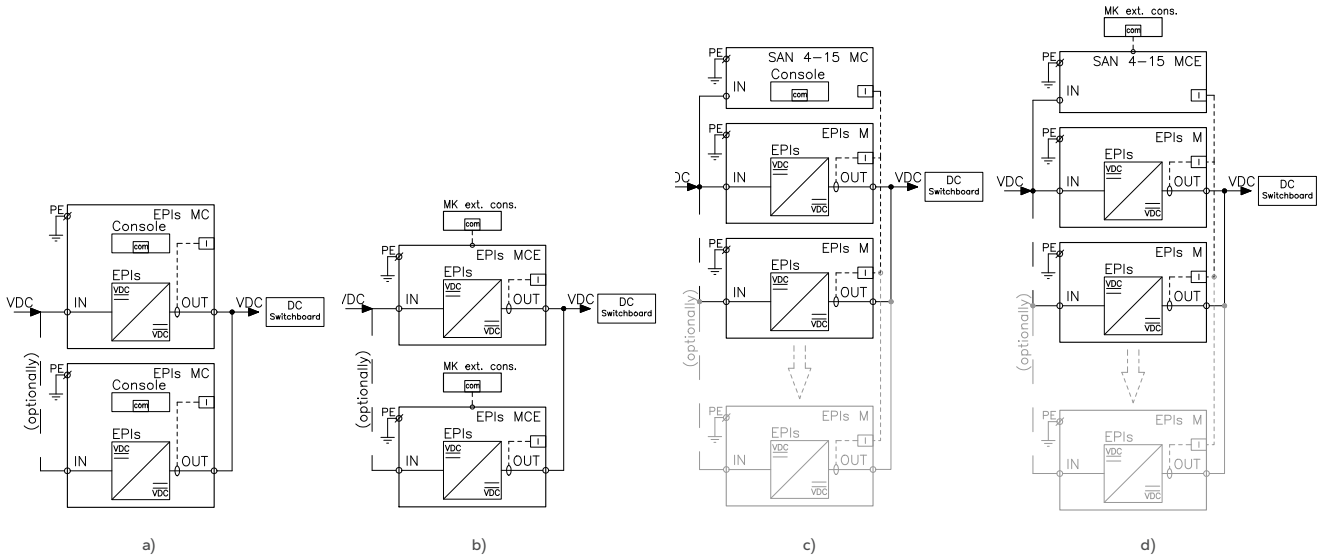


Fig. 30. Block diagram of the converter modules without the EPIs type insulation for parallel operation:
a) the EPIs MC type modules system; b) the EPIs MCE type modules system with an external MK console;
c) the EPIs M type modules and the SAN 4-15 MC type controller system; d) the EPIs M type modules and the SAN 4-15 MCE type controller system with an external MK console.

The EPI/EPIs type DC/DC converter module is supplied by direct current (DC). The modules with a built-in console belong to the MC modules family – Fig. 27 a), Fig. 28 a), the modules with an external MK console belong to the MCE modules family – Fig. 27 b), Fig. 28 b), and the modules without the console are a part of the M modules family – Fig. 27 c), Fig. 28 c).

The EPI/EPIs converter converts direct supply voltage to direct voltage of the value provided in the specification. In the EPI type converters, the galvanic separation of the converter's DC output voltage from the DC supply voltage is ensured by a high-frequency insulating transformer located in the converter at the supply side, while in the EPIs type converters, the output voltage is not galvanically insulated from the input voltage. The EPI type converter features voltage stabilising functions on a wide range of changes of the supply voltage. The EPIs type converter also features the load voltage stabilisation, but only during excessive discharge of the battery, i.e., it may only increase the DC input voltage.

The devices may operate on their own (autonomously – Fig. 27, Fig. 28) or in n×EPI configuration (in parallel – Fig. 29, Fig. 30). The EPI / EPIs MC and EPI / EPIs MC modules for parallel operation do not require an external controller.

The EPI / EPIs M modules are adapted to parallel operation via use of an external controller in systems consisting of a larger number of modules (>4).

An external controller is used for control, monitoring, and visualisation of operating and emergency states of the system. The external controller modules with a built-in console are a part of the MC family – Fig. 29 c), Fig. 30 c), while the controller modules with an external console belong to the MCE modules family – Fig. 29 d), Fig. 30 d) of the overall dimensions of the M4 module, presented in Fig. 31 a, c).

Optionally, the EPI MC converter may be used to charge the battery as a battery power supply supplied by direct current. In such a case, the controller is equipped with a UI type charging algorithm accordant with EUROBAT.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

SERIES TYPE: THE EPI TYPE DC/DC CONVERTERS MODULE FOR AUTONOMOUS AND PARALLEL OPERATION

Rated output current, [A]	DC rated output voltage, [V]	DC rated input voltage, [V]	Example type	Enclosure dimensions**
10 / 20	24	24	EPI 24/24/10 MC*	M4
10	48		EPI 24/48/10 MC*	
10 / 25	24 /48 / 60	48	EPI 48/24/10 MC*	
10 / 25		60	EPI 60 / 24/10 MC*	
10 / 20	120		EPI 60 / 120 / 10 MC*	
20 / 30 / 25 / 50 / 75 / 100	24	110	EPI 110 / 24/20 MC*	
150			EPI 110 / 24/150 MC*	M3
20 / 25 / 30 / 50	48		EPI 110 / 48/20 MC*	M4
75 / 100			EPI 110 / 48/75 MC*	M3
20 / 25 / 30	60		EPI 110 / 60 / 20 MC*	M4
50 / 75			EPI 110 / 60/50 MC*	M3
20 / 25	110		EPI 110 / 110 / 20 MC*	M4
30 / 50			EPI 110 / 110/30 MC*	M3
10	220		EPI 110 / 220 / 10 MC*	M4
25			EPI 110 / 220 / 25 MC*	M3
20 / 25 / 30 / 50 / 100 / 150 / 200	24	220	EPI 220 / 24/20 MC*	M4
350			EPI 220 / 24/350 MC*	M3
20 / 25 / 30 / 50 / 75 / 100	48		EPI 220 / 48/20 MC*	M4
150			EPI 220 / 48/150 MC*	M3
20 / 25 / 30 / 50	60		EPI 220 / 60 / 20 MC*	M4
75 / 100			EPI 220 / 60/75 MC*	M3
20 / 25 / 30 / 50	110		EPI 220 / 110 / 20 MC*	M4
75 / 100			EPI 220 / 110/75 MC*	M3
25	220		EPI 220 / 220 / 25 MC*	M4
30 / 50			EPI 220 / 220/30 MC*	M3

* – possible options: M / MC / MCE;

** – M4 (4U): 482×142×496; M3 (6U): 482×267×496. (W×H×D).

SERIES TYPE: THE EPIs TYPE DC/DC CONVERTERS MODULE FOR AUTONOMOUS AND PARALLEL OPERATION

Rated output current, [A]	DC rated output voltage, [V]	DC rated input voltage, [V]	Example type	Enclosure dimensions**
10 / 20 / 50	24 / 48 / 60 / 110 / 220	24 / 48 / 60 / 110 / 220	EPIs 24/24/10 MC*	M4
75			EPIs 24/24/75 MC*	M3

* – possible options: M / MC / MCE;

** – M4 (4U): 482×142×496; M3 (6U): 482×267×496. (W×H×D).

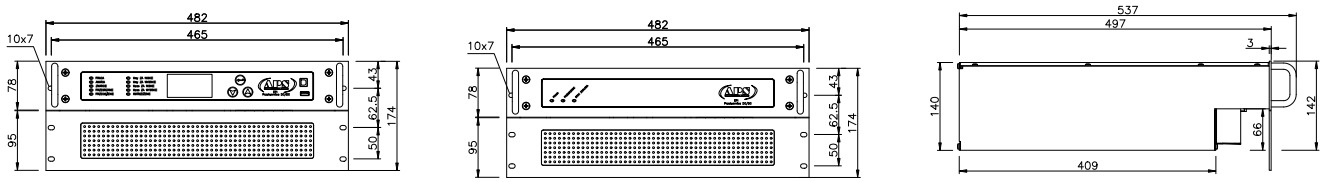


Fig. 31. Views with dimensions of the EPI M / MC / MCE type converter module in the M4 enclosure:
a) front view – a module with a built-in console; b) front view – a module without a console; c) left-side view.

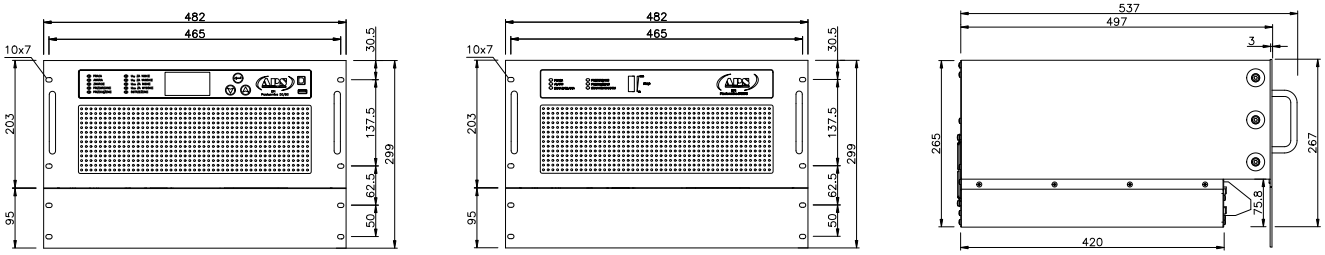


Fig. 32. Views with dimensions of the EPI M / MC / MCE type converter module in the M3 enclosure:
a) front view – a module with a built-in console; b) front view – a module without a console; c) left-side view.

CONVERTERS BUILT IN A CABINET

This chapter presents the EPI type DC/DC converters in a form of a 19" industrial cabinet adapted for installation on a substrate. The main task of a DC/DC converter is to continuously supply loads with DC guaranteed voltage.

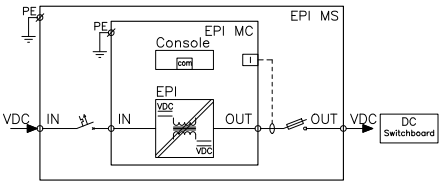
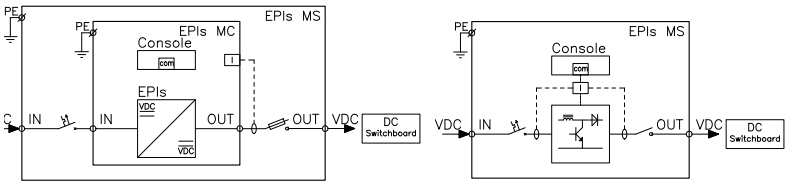
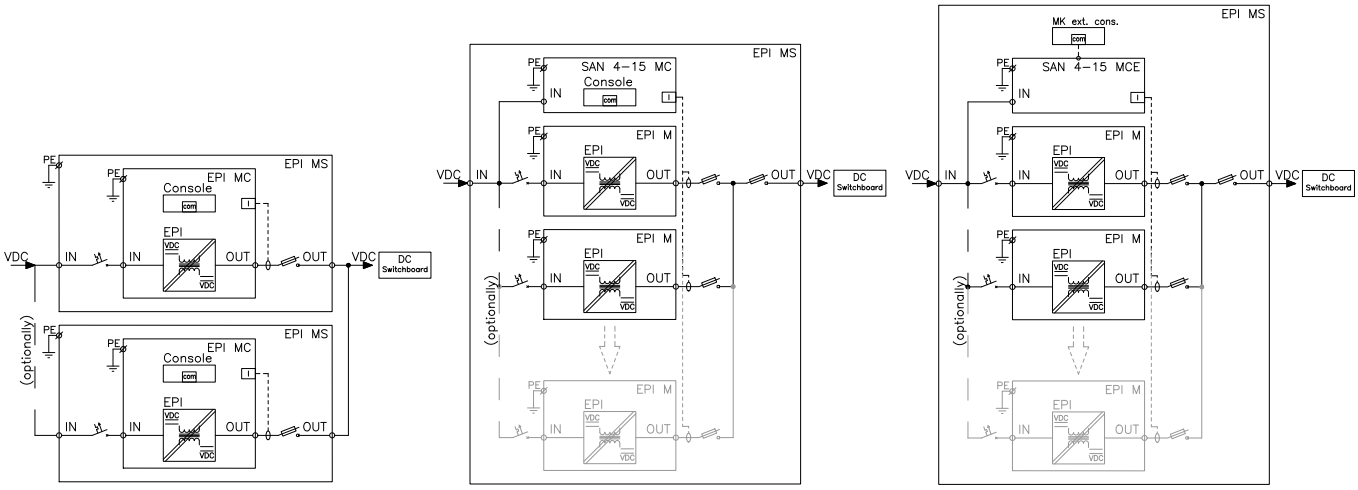


Fig. 33. Block diagram of the EPI type converter cabinet for autonomous operation



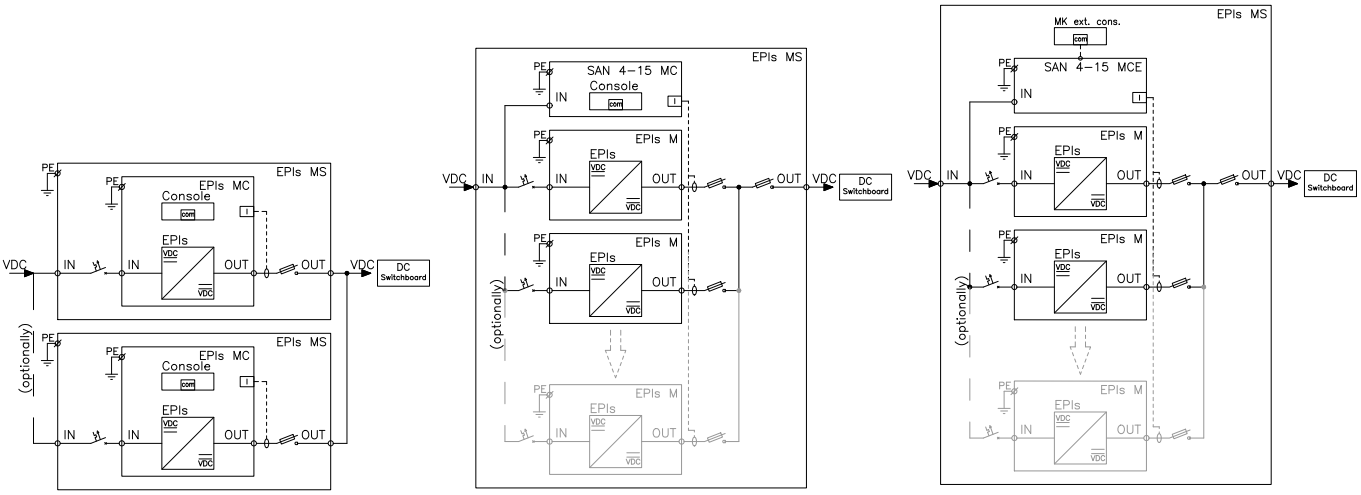
a) b)

Fig. 34. Block diagram of the EPIs type converter cabinet for autonomous operation: a) modular design; b) free design.



a) b) c)

Fig. 35. Block diagram of the EPI type converter cabinet for parallel operation: a) a system with EPI MC; b) a system with EPI M and an external SAN 4-15 MC controller with a built-in console; c) a system with EPI M and an external SAN 4-15 MCE controller with an external MK console.



a) b) c)

Fig. 36. Block diagram of the EPIs type converter cabinet for parallel operation: a) a system with EPIs MC; b) a system with EPIs M and an external SAN 4-15 MC controller with a built-in console; c) a system with EPIs M and an external SAN 4-15 MCE controller with an external MK console.

The EPI / EPIs MC type converters are multi-module power supply systems intended for supplying loads with DC voltage. The DC/DC converters is based on the EPI / EPIs type modules in the M or MC enclosure. The description of the modules is provided in the chapter "MODULAR DESIGN CONVERTERS". The modules feature a compact design, optimised for operating conditions of the modules. The functionality of the EPI / EPIs MS systems allows designing converters of significant output power, as well as more complex systems.

Fig. 33 – Fig. 36 present a standard solution for converters are built in an industrial cabinet. The devices may operate on their own (autonomously – Fig. 33) or in n×EPI configuration (in parallel – Fig. 35).

Fig. 33, Fig. 34 a), Fig. 35, and Fig. 36 present EPI / EPIs MS converters in a modular design, while Fig. 34 b) presents the EPIs MS converter in a form of a free design of elements in an industrial cabinet.

The EPI/EPIs converter converts direct supply voltage to direct voltage of the value provided in the specification. In the EPI type converters, the galvanic separation of the converter's DC output voltage from the DC supply voltage is ensured by a high-frequency insulating transformer located in the converter at the supply side, while in the EPIs type converters, the output voltage is not galvanically insulated from the input voltage. The EPI type converter features voltage stabilising functions on a wide range of changes of the supply voltage. The EPIs type converter also features the load voltage stabilisation functions, but only during excessive discharge of the battery, i.e., it may only increase the DC input voltage.

The system presented in Fig. 35 a), Fig. 36 a) may have up to 4 converter modules.

The system presented in Fig. 35 b), c), Fig. 36 b), c) may include up to 16 converter modules.

The industrial cabinet is cooled by a forced air circulation via redundant roof fans. Moreover, each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

SERIES TYPE: THE EPI TYPE DC/DC CONVERTER CABINET 10 ÷ 1500 A

Rated output current, [A]	DC rated output voltage, [V]	DC rated input voltage, [V]	Example type	Modules configuration*	Max. enclosure dimensions [W×D×H**], [mm]
80	24	24	EPI 24/24/80 MS	4×20 A	600×800×2,000
160			EPI 24/24/160 MS	8×20 A	1,200×800×2,000
40	48		EPI 24/48/40 MS	4×10 A	600×800×2,000
80			EPI 24/48/80 MS	8×10 A	1,200×800×2,000
100	24 / 48 / 60	48 / 60	EPI 48/24/100 MS	4×25 A	600×800×2,000
200			EPI 48/24/200 MS	4×25 A	1,200×800×2,000
80	120	60	EPI 60 / 120/80 MS	4×20 A	600×800×2,000
160			EPI 60 / 120 / 160 MS	8×20 A	1,200×800×2,000
400	24	110	EPI 110 / 24/400 MS	4×100 A	600×800×2,000
				3×150 A	
600			EPI 110 / 24/600 MS	6×100 A	1,200×800×2,000
				4×150 A	
900			EPI 110 / 24/900 MS	6×150 A	1,400×800×2,000
200	48		EPI 110 / 48/200 MS	4×50 A	600×800×2,000
				2×100 A	
400			EPI 110 / 48/400 MS	8×50 A	1,200×800×2,000
				4×100 A	
600			EPI 110 / 48/600 MS	6×100 A	1,200×800×2,000
100	60		EPI 110 / 60 / 100 MS	3×30 A	600×800×2,000
				2×50 A	
200			EPI 110 / 60 / 200 MS	3×75 A	
300			EPI 110 / 60/300 MS	4×75 A	1,200×800×2,000
100	110		EPI 110 / 110 / 100 MS	4×25 A	600×800×2,000
				2×50 A	
200			EPI 110 / 110 / 200 MS	8×25 A	1,200×800×2,000
				4×50 A	
300			EPI 110 / 110/300 MS	6×50 A	
40	220		EPI 110 / 220 / 40 MS	4×10 A	600×800×2,000
				2×25 A	
75			EPI 110 / 220/75 MS	3×25 A	600×800×2,000
150			EPI 110 / 220 / 150 MS	6×25 A	1,200×800×2,000
300			EPI 110 / 220/300 MS	9×25 A	1,800×800×2,000
800	24	220	EPI 220 / 24/800 MS	4×200 A	800×800×2,000
				3×350 A	
1,500			EPI 220 / 24/1500 MS	5×350 A	1,600×800×2,000
400	48		EPI 220 / 48/400 MS	4×100 A	800×800×2,000
				3×150 A	
750			EPI 220 / 48/750 MS	5×150 A	1,600×800×2,000
200	60		EPI 220 / 60 / 200 MS	4×50 A	600×800×2,000
				2×100 A	
300	60 / 110		EPI 220 / 60/300 MS	3×100 A	
600			EPI 220 / 60 / 600 MS	6×100 A	1,200×800×2,000
100	220		EPI 220 / 220 / 100 MS	4×25 A	600×800×2,000
				2×50 A	
300			EPI 220 / 220/300 MS	6×50 A	1,200×800×2,000

* – max. 1,500 A, but no more than 16 modules working in parallel;

** – add the height of the pedestal to the height of the device: by standard, 100 mm.

SERIES TYPE: THE EPIs TYPE DC/DC CONVERTER CABINET 50 ÷ 900 A

Rated output current, [A]	DC rated output voltage, [V]	DC rated input voltage, [V]	Example type	Modules configuration	Max. enclosure dimensions [W×D×H*], [mm]
200	220	220	EPIs 220 / 220 / 200 MS	4×50 A	600×800×2,000
				3×75 A	
300			EPIs 220 / 220/300 MS	4×75 A	1,200×800×2,000
600			EPIs 220 / 220 / 600 MS	Free design	800×800×2,000
900			EPIs 220 / 220/900 MS		1,200×800×2,000

* – add the height of the pedestal to the height of the device: by standard, 100 mm.

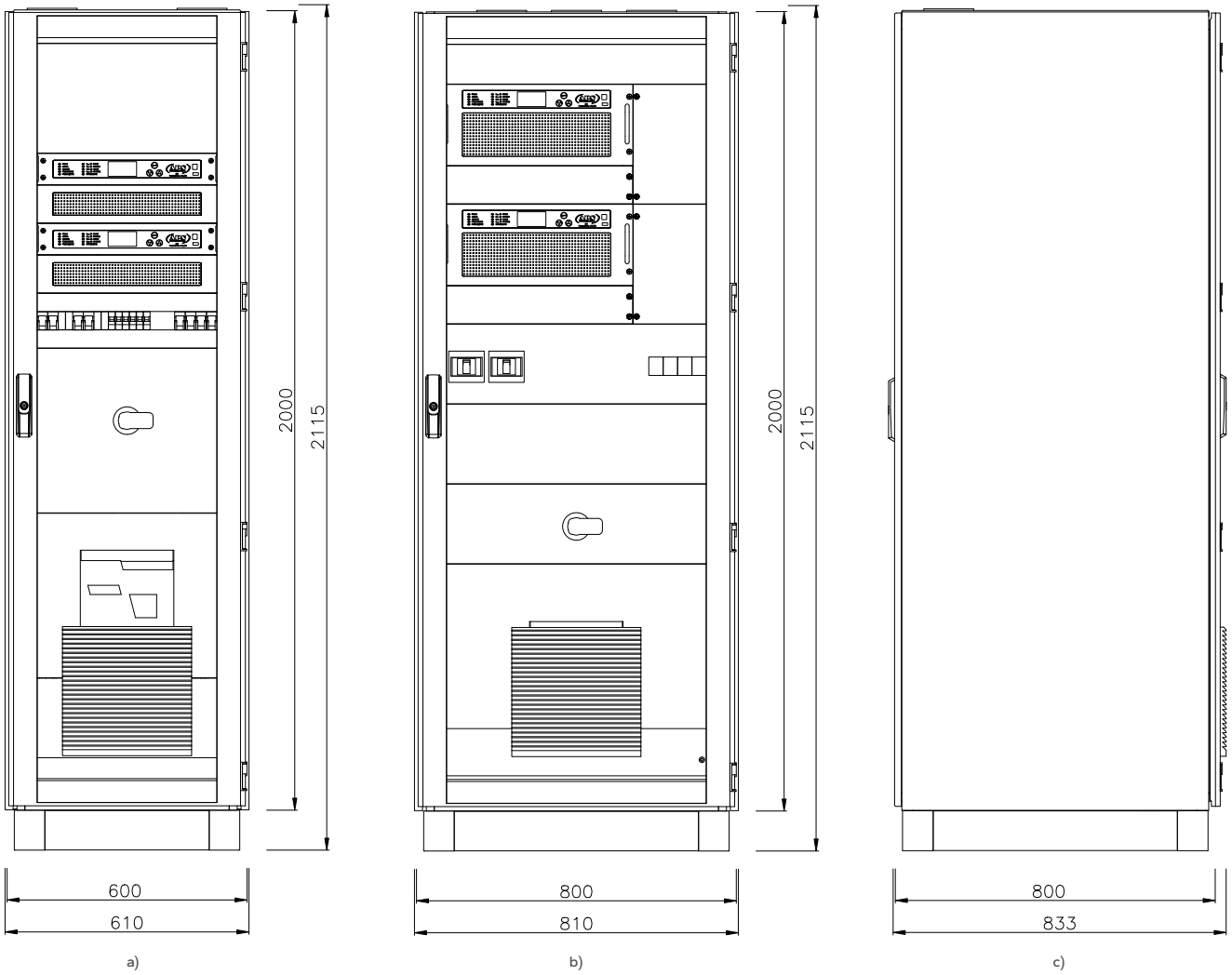
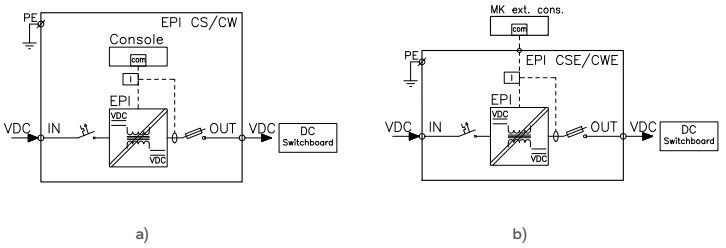


Fig. 37. Views with dimensions of the EPI / EPIs converter cabinet:
a) 600×800×2,000 cabinet – front view; b) 800×800×2,000 cabinet – front view; c) cabinet of depth of 800 mm – left-side view.

COMPACT DESIGN CONVERTERS

This chapter presents the type EPI DC/DC converters in a compact form. They are intended for installation on a substrate (CS standing compact) or on a wall (CW wall-mounted compact). The main task of a DC/DC converter is to continuously supply loads with DC guaranteed voltage.



a) b)

Fig. 38. Block diagram of the EPI type converter compact for autonomous operation: a) with a built-in console; b) with an external MK console.

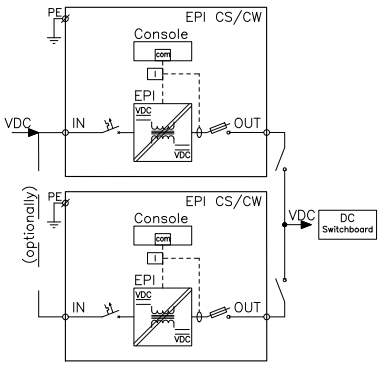


Fig. 39. Block diagram of the EPI type converter compact for parallel operation.

The EPI type converter compact is intended for supplying loads with DC voltage.

A compact with a built-in console is presented in Fig. 38 a), while compacts with an external MK consoles are presented in Fig. 38 b).

The converter converts direct supply voltage to direct voltage of the value provided in the specification. The galvanic separation of the converter's DC output voltage from the DC supply voltage is ensured by a high-frequency insulating transformer located in the converter at the supply side.

The devices may operate autonomously (Fig. 38) or in parallel (Fig. 39).

The compact is cooled by a forced air circulation via fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

SERIES TYPE: THE EPI TYPE DC/DC CONVERTER COMPACTS 10 250 A FOR AUTONOMOUS AND PARALLEL OPERATION

Rated output current, [A]	DC rated output voltage, [V]	DC rated input voltage, [V]	Example type	Enclosure dimensions**
10 / 20	24	24	EPI 24/24/10 CS*	CS4 / CW4
10	48		EPI 24/48/10 CS*	
10 / 25	24 / 48 / 60	48 / 60	EPI 48/48/10 CS*	
20	120	60	EPI 60 / 120 / 20 CS*	
10 / 20 / 50 / 75 / 100	24	110	EPI 110 / 24/10 CS*	
150			EPI 110 / 24/150 CS*	CS6 / CW6
10 / 20 / 50	48		EPI 110 / 48/10 CS*	CS4 / CW4
100			EPI 110 / 48/100 CS*	CS6 / CW6
10 / 20 / 30	60		EPI 110 / 60 / 10 CS*	CS4 / CW4
75			EPI 110 / 60/75 CS*	CS6 / CW6
10 / 25	110		EPI 110 / 110 / 10 CS*	CS4 / CW4
50			EPI 110 / 110/50 CS*	CS6 / CW6
10	220		EPI 110 / 220 / 10 CS*	CS4 / CW4
25			EPI 110 / 220 / 25 CS*	CS6 / CW6
100	24	220	EPI 220 / 24/100 CS*	CS4 / CW4
250			EPI 220 / 24/250 CS*	CS6 / CW6
100	48		EPI 220 / 48/100 CS*	CS4 / CW4
150			EPI 220 / 48/150 CS*	CS6 / CW6
50	60 / 110		EPI 220 / 60/50 CS*	CS4 / CW4
100			EPI 220 / 60 / 100 CS*	CS6 / CW6
25	220		EPI 220 / 220 / 25 CS*	CS4 / CW4
50			EPI 220 / 220/50 CS*	CS6 / CW6

* – possible options: CS / CSE / CW / CWE;

** – CS4: 400×(2×600)×250; CS6: 500×(2×700)×250; CW4: 400×600×250; CW6: 500×700×250. (W×H×D).

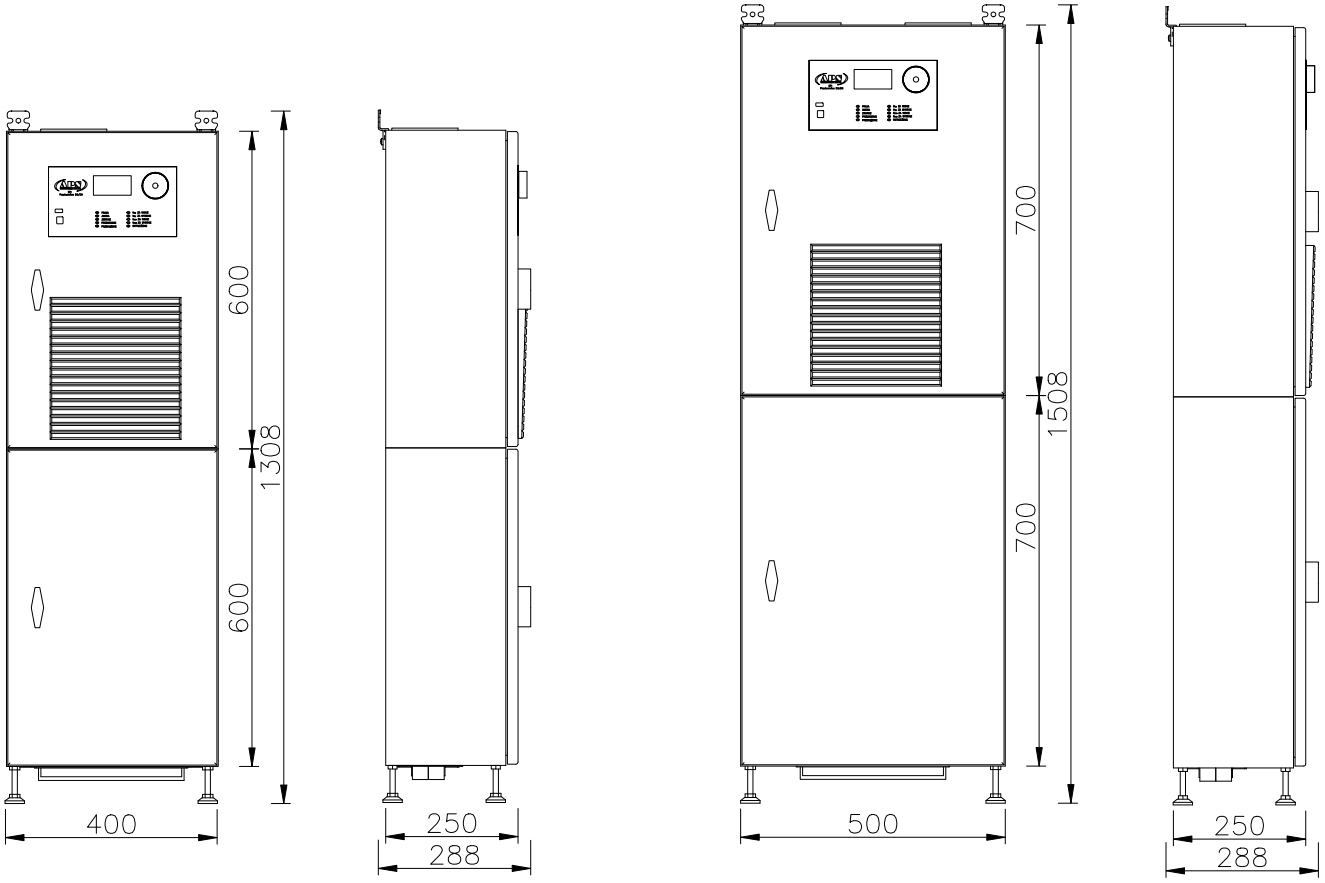


Fig. 40. Views with dimensions of the EPI type converter compact (standing enclosure):
a) CS4 compact – front view; b) CS4 compact – left-side view; c) CS6 – front view; d) CS6 compact – left-side view.

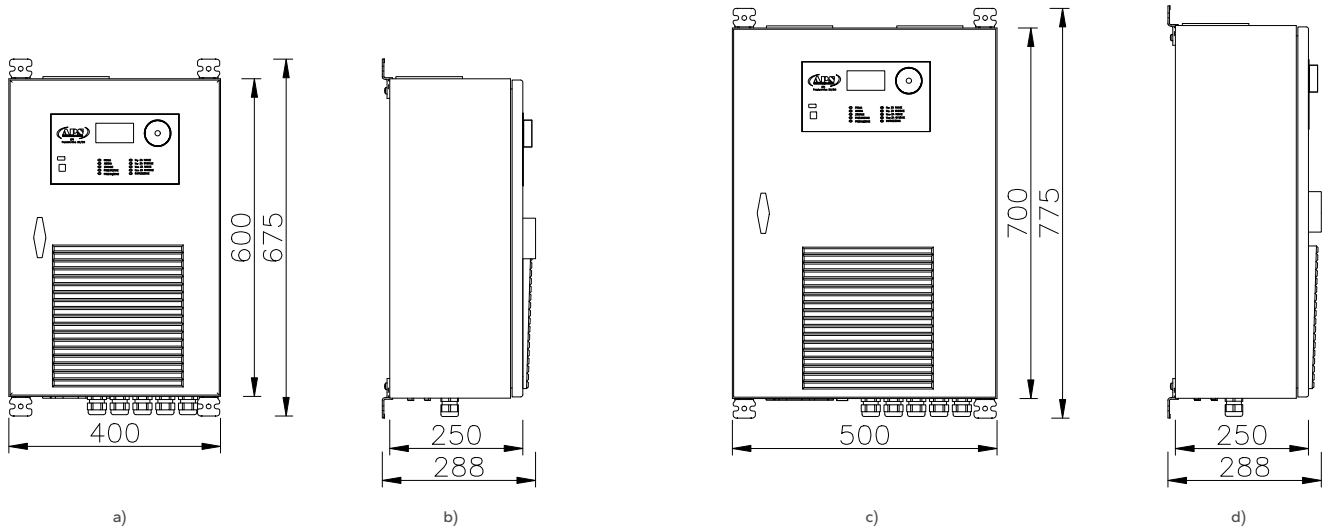


Fig. 41. Views with dimensions of the EPI type converter compact (wall-mounted enclosure):
a) CW4 compact – front view; b) CW4 compact – left-side view; c) CW6 – front view; d) CW6 compact – left-side view.

BATTERY DISCHARGE UNIT

The BRI discharger is intended for controlled discharge of the chemical battery with an applied direct current.

The controlled battery discharge is carried out in accordance with the guidelines of the producer in a way to allow comparing the measurement results with the factory data. BRI measures the battery's temperature during the battery test discharge, and applies a temperature correction to the measured values.

The device allows remote setting of parameters and reading data using APS6000 (APS Energia SA external protocol) and Modbus RTU communication protocols.

It is possible to connect the dischargers in parallel to multiply the maximum discharge current. The process is fully automatic.

The discharger is equipped in a microprocessor operation and battery state control system.

The LCD signals the following:

- battery's voltage;
- battery's discharge current;
- the charge drawn from the battery;
- operation time and the set discharge time;
- the date and time of start and end of the discharge;
- external temperature;
- the measured capacity of the battery including the external temperature.

METHOD OF DESIGNATION OF THE BRI TYPE DISCHARGER

BRI □-□/□ □

Device type: BRI - battery discharge unit
Rated battery voltage range, [V]
Maximum battery discharge current, [A] Solution depends on the order
Type of enclosure: CP - portable compact

The discharger view

THE BRI TYPE DISCHARGER – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE	
DC INPUT		
U_{BAT} output voltage	12 to 400 V	12 to 540 V
U_{MAX} maximum output current	450 V	545 V
U_{MIN} minimum output voltage	9 V	
AC INPUT (auxiliary)		
Input voltage	230 V ±10 %	
Frequency of the input voltage	50 Hz ±10 %	
DC OUTPUT		
I_{ZN} rated discharge current	50 A	30 A
P_{ZN} maximum power loss	12 kW	16 kW
I_{ROZ} maximum discharge current	If $P>P_{ZN}$, so $I_{ROZ}= P_{ZN} / U_{BAT}$ if $P<P_{ZN}$, then $I_{ROZ}=I_{ZN}$	
Discharge current stabilisation	<1 %	
Discharge current ripple	<3 %	
Available menu language versions	PL | EN | CZ | RU	
OPERATING ENVIRONMENT		
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*	
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*	
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*	
Access to the device	from the front and the back	
Cable entry	from the back	
Maximum height above the sea level without change of the rated parameters	1,000 m ASL	

* – it is possible to design different parameters upon agreement with the manufacturer.

THE CHARACTERISTICS OF THE BRI TYPE DISCHARGER

The microprocessor controlled BRI type control discharge device is characterised by the following parameters:	• automatic completion of the discharge process after achieving set parameters; • low ripple and low level of higher harmonics of the current drawn from the battery; • displaying and archiving discharge parameters; • remote operation control and readout of parameters (APS6000 and Modbus RTU); • compact dimensions and low weight; • a mobile design with wheels for easy transport.
The device is protected against:	• overheating; • exceeding the maximum permissible voltage.
The discharger monitors the critical structural elements and indicated emergency states:	• damage of the internal temperature sensor; • damage of the external temperature sensor; • no parallel communication; • fan(s) damage; • incorrect polarisation of the battery.

THE BRI DISCHARGER USER INTERFACE

There is a control panel console on the front panel of the discharger. The glowing LEDs system and the LCD allows monitoring the operation of the device and reading the measured values.

The controlled discharge process parameters are set via 3-button keyboard and the graphic LCD located on the front panel or remotely through RS485 or USB links. Discharge is carried out until the battery's voltage reaches the set minimum level or until the set discharge time elapses.

The device allows connecting with a master system (e.g., a PC) via the RS485 (connection fields) or USB-B (front panel) links. The user may use two programs: "SAN DIR" and "BRI archive explorer," which communicate using the external APS6000 protocol. By standard, the Modbus RTU industrial communication protocol is also implemented.

Device's communication links:

- RS485 and USB B for communication with a master system (e.g., a PC).
- USB A for copying archival data to a Flash memory drive.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BAT – battery	IN – power supply

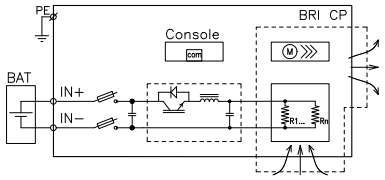
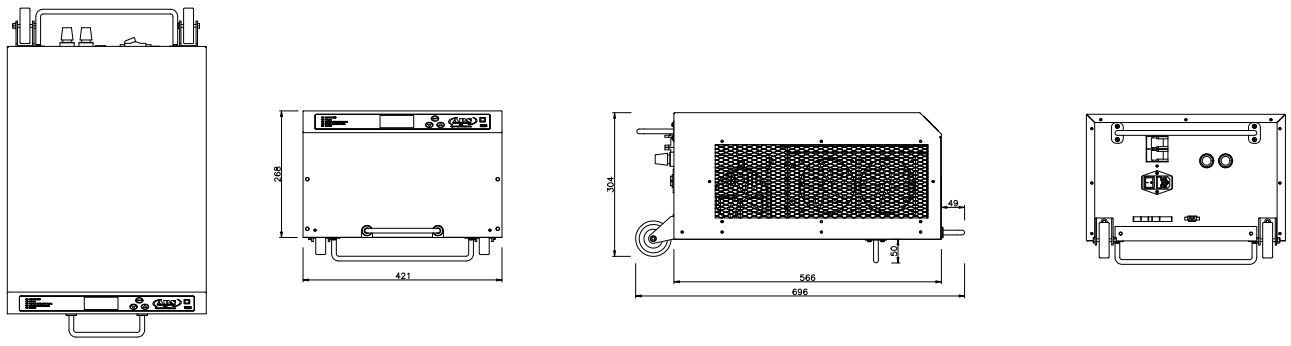


Fig. 42. Block diagram of the BRI type discharger compact.

SERIES TYPE: BRI TYPE DISCHARGER COMPACTS

DC rated input voltage, [V]	Rated discharge current, [A]	Example type	Enclosure dimensions*
from 12 to 400	50	BRI 12-400/50 CP	CP
from 12 to 540	30	BRI 12-540 / 20 CP	
Special version from 110 to 650	20	BRI 110-650 / 20 CP	

* – CP: 400×600×250. (W×H×D).



a) b) c) d)

Fig. 43. Views with the dimensions of the BRI type discharge mobile compact:
a) CP compact – top view; b) CP compact – front view; c) CP compact – left-side view; d) CP compact – back view.

INDUSTRIAL INVERTERS

An inverter, a direct current (DC) to alternating current (AC) converter, is a basic element of the guaranteed power supply systems.

The tasks of the guaranteed power supply systems in the industry is supplying critical loads which require uninterrupted power supply due to the necessity to maintain continuity of technological processes or/and perfect supply voltage parameters for proper and reliable operation.

The guaranteed power supply makes operation of crucial, from the point of view of the technological process, loads independent of the parameters of the power grid, and in the case of power failure, it ensures continuity of power supply from a reserve energy source. In the energy technology and industry, the accumulator battery or another DC energy storage is such a source.

THE BFI TYPE INVERTER CHARACTERISTICS:

The BFI type inverters – modern, microprocessor-controlled power electronics systems (DSP), operating using the high-frequency technique based on IGBT transistors with Pulse Width Modulation (PWM) – are characterised by:

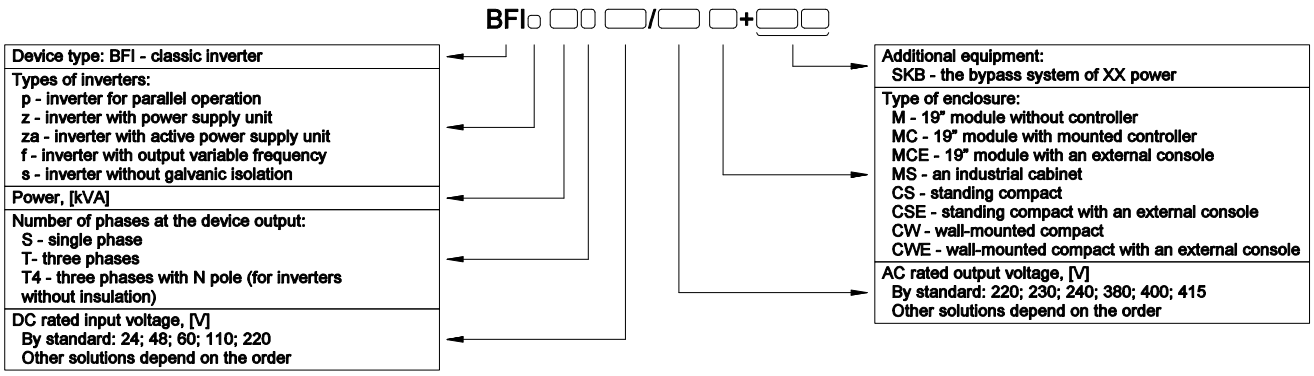
- perfectly sinusoidal output voltage shaped based on a digital pattern, minimum content of harmonic THDu;
- high stability of voltage and output frequency, both in steady and dynamic state;
- galvanic isolation of the DC and AC circuits;
- high efficiency;
- possible 100 % asymmetrical load (for three-phase inverters);
- high resistance to overload and difficult operating conditions;
- ability to operate at load characterised by any cos φ (supplying loads of inductive or capacitive nature);
- high short-circuit current factor from Izw=3×In to Izw=9×In (high selectiveness of tripping of protections);
- electromagnetic compatibility (EMC), EMI filters on input and output circuits of the device – limitation of the conducted disturbances emission, and high resistance to electromagnetic disturbances at the same time;
- advanced communication between the user and the device: keyboard, control console with LCD, indicating LEDs, application of all binary signals to potential-free relay contacts;
- data archiving and events buffer on SD card;
- RS485, USB and Ethernet integrated communication interfaces;
- wide selection of data transmission protocols: Modbus RTU, Modbus TCP, IEC 60870-5-103, IEC 61850, SNMP, APS6000, other;
- over-current, over-voltage, short-circuit protection;
- parallel operation with equalisation of currents, possible parallel operation of inverters to increase the power or reliability (n+1 type redundancy);
- SAN 8 microprocessor monitoring of the entire system.

View of the inverter module

View of the inverter compact

View of the inverter cabinet in a modular design

METHOD OF DESIGNATION OF THE BFI TYPE INVERTERS



AC inverters are power electronics converters that convert direct current to alternating current. They are designed to supply alternating current to loads that require high quality power supply parameters. They have two autonomous inputs:1) basic – AC input [single-phase or three-phase] and 2) reserve – DC input. BFIz inverters may be supplied by different AC and DC voltages. Switching between AC and DC supply is done without interruptions, based on the difference of potentials on the inverter's DC intermediate voltage bus. BFIz inverters are double VFI conversion systems. The configuration and adaptation capabilities of those systems make them one of the most versatile and widely used devices in the field of uninterrupted power supply. BFIz inverters are used mainly in UPSs and central or local guaranteed power supply systems.

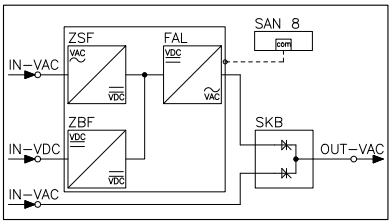


Fig. 44. General block diagram of the inverter system with the BFIz power supply unit and the SKB type bypass

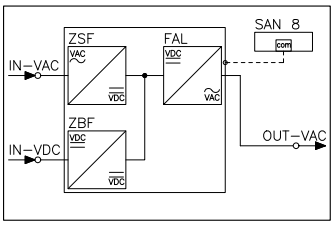


Fig. 45. General block diagram of the inverter system with the BFIz power supply unit

Static Switch. To improve reliability of the system, the BFIz inverters are most often used together with the SKB (Static Switch). The SKB system (automatic bypass) is a quick thyristor link that ensures switching of loads to AC reserve power supply in the case of a failure of an inverter. In the case of break of alternating voltage on the bypass's basic line (inverter output voltage), the SKB will automatically switch power supply of loads to the AC reserve line, bypassing the BFIz inverter. The switching time is 5 ms or 10 ms (depending on the synchronisation of those voltages).

Fig. 44 presents the most common solution: the BFIz type inverter cooperating with the Static Switch system. This cooperation may take place in the "online" or "offline" mode. In the online operation mode, the basic power supply of the Static Switch system is the output voltage of the inverter, while the reserve power supply function is provided by the reserve AC network. In the offline operation mode, the basic power supply of the Static Switch system is the AC reserve network, while the reserve power supply function is provided by the output voltage of the inverter. The BFIz inverter systems, both with (Fig. 44) and without (Fig. 45) a bypass system, may operate in a parallel configuration to increase the power or to improve the system's reliability. Each inverter may cooperate with SAN 8 (the automatic monitoring system), which ensures monitoring, registration, and visualisation of all operating states of the system, as well as alarming in the case of occurrence of an alarm state.

In the cabinet version, the inverter's power supply may be active, characterised by a sinusoidal current draw from the mains.

An inverter without a power supply is designated as BFI. The basic supply voltage of the BFI inverter is only the direct current source (the battery or a DC distribution board).

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BR – maintenance bypass	INV – inverter
IN – power supply	IN-ACF – AC supply from the inverter
IN-ACF – AC supply from the mains	MD – diode bridge
OUT – output	SAN 8 – console
SKB – automatic bypass	TR – 50 Hz transformer
VAC – basic or reserve AC power supply	VDC – DC power supply
ZBF – inverter's power supply from DC voltage	ZSF – inverter's power supply from AC voltage
com – communication	U – voltage measurement

THE TYPE BFIz / BFI INVERTERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER		VALUE
AC POWER SUPPLY OF THE INVERTER (mains)*		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		+10 % to -15 %
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
DC POWER SUPPLY OF THE INVERTER		
Input voltage		24 / 48 / 60 / 110 / 220 V
Input voltage tolerance		±20 %*
AC POWER SUPPLY OF THE BYPASS (backup mains)**		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		±15 %
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
AC OUTPUT OF THE INVERTER		
Output voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Voltage stability (static)		±1 %
Voltage stability (dynamic)		± 5 % within 10 ms
Voltage waveform		sinusoidal
THDu voltage distortion (linear load)		<2 %
THDu voltage distortion (non-linear load)		<5 %
Output voltage frequency		50 / 60 Hz*
Output voltage frequency tolerance		±0.1 %
Overload capacity at resistance load		<110 % constant, ≤125 % 10 min, ≤150 % 1 min
Short-circuit current		3×In (up to 9×In for the HC version)***
Crest factor		3:1 (optionally up to 5:1)
Cos φ range		from 0.7 to 1.0
Inverter efficiency		85 to 95 %
Electromagnetic compatibility		EN IEC 62040-2
Available menu language versions		PL | EN | CZ | RU
OPERATING ENVIRONMENT		
Operating temperature (EN 50178 class 3k3)		+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)		-25 to +55 °C*
Humidity (EN 50178 class 3k3)		5 to 85 % (non-condensing)*
Access to the device		operation and maintenance from the front*
Cable entry		from the bottom / from the top****
Maximum height above the sea level without change of the rated parameters		1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;

** – only for inverters equipped with the Static Switch bypass system (SKB or MWB);

*** – see chapter "Inverter module of increased short-circuit current"

**** – only for installation in the industrial cabinet (MS enclosure type).

TYPICAL DESIGNS OR EQUIPMENT OPTIONS FOR INVERTERS

Special designs	Upon request, it is possible to adapt the devices to special requirements of a given project in relation to: • greater power of inverters; • range of DC input voltages; • standard of the AC voltages and frequencies; • single-phase inverters: e.g., 110 V, 115 V, 120 V, 127 V, 50/60 Hz; • three-phase inverters: e.g., 3×190 V, 3×200 V, 3×208 V, 3×220 V, 50/60 Hz; • extension of the range of DC and AC input voltages (BFIz); • environmental requirements related to ambient temperature (-20 °C ÷ +55 °C), presence of aggressive factors, etc.; • enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.; • measurements and communication: digital or analogue meters of appropriate class, indication of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.
ATSE system (duplex power supply)	The automatic transfer switching equipment (ATSE) decides about the selection of the source of power for a device. When the source I supply voltage presence, the inverter (BFIz type) is supplied from this source. In the case of its break (complete or one of its phases), the ATSE system automatically switches the BFIz inverter power supply to source II.
Power supply 1f (single-phase power supply)	By standard, the BFIz type inverters are equipped with a three-phase power supply unit. For low powers, or in special cases, there is a possibility to use a single-phase power supply.
Protection of circuits at the input and the output	The BFI type inverters (DC/AC converter) and the BFIz inverter (AC/DC/AC converter) are power electronics converters with power circuits and output circuits. Over-current protections of those circuits may be built in the inverter itself or be located in external distribution boards or distribution panels.
Isolating transformer at the input	In the normal operation mode, it is used to ensure galvanic isolation between two internal circuits of the inverter and the mains. It allows obtaining increased safety and reliability of the system.
Automatic bypass	The microprocessor bypass system (the internal system of connections with the SKB type static switch) ensuring uninterrupted (<5 ms), automatic switching of loads to supply from a reserve network in emergency situations. Voltage on the reserve line is measured continuously; switch to a reserve line may take place only when the reserve line parameters are within the tolerance.
Isolating transformer at bypass circuit	It is used to ensure galvanic isolation of power supply and power supplying circuits also during operation in the bypass mode. The transformer is necessary on the bypass circuit when the IT system power supply (a network isolated to the grounding) is required at the output of the inverter. A special version allows limiting short-circuit currents when operation from the bypass.
Maintenance bypass	A mechanical switch that enable manual switching of loads to power supply from a reserve supply network. The maintenance bypass switch has 3 positions (with a switching gap).
Uninterrupted maintenance bypass	A mechanical switch that enable uninterrupted manual switching of loads to power supply from a reserve supply network. The two-position maintenance bypass switch is synchronised with the automatic bypass.
Isolating output transformer	During normal operation, the transformer eliminates the alternating voltage constant component, which is particularly important for supplying loads of inductive nature. In the case of a failure, it isolated AC output circuits from DC circuits, preventing damage to the loads. The output transformer is necessary when the IT system power supply (a network isolated to the grounding) is required at the output of the inverter.
Parallel operation	Possibility of operation of two or more inverters on the common AC guaranteed voltage bus. The control algorithm of the inverters ensures synchronisation of output voltages of particular inverters and even power distribution.
Built-in output circuits distribution board	In the inverter's enclosure, you may separate a space and incorporate an AC guaranteed voltage distribution panel equipped with protections for particular input circuits.
Active input filter (sinusoidal current draw from the mains)	To limit the introduced disturbances to the mains, you may use a parallel active filter to achieve a sinusoidal characteristics of the current draw from the mains by the inverter (BFIz).
Cable entry from the top	It is possible to design the enclosure in a way to allow cables entering from the top.

*NOTE: Use of options may change the dimensions of the device

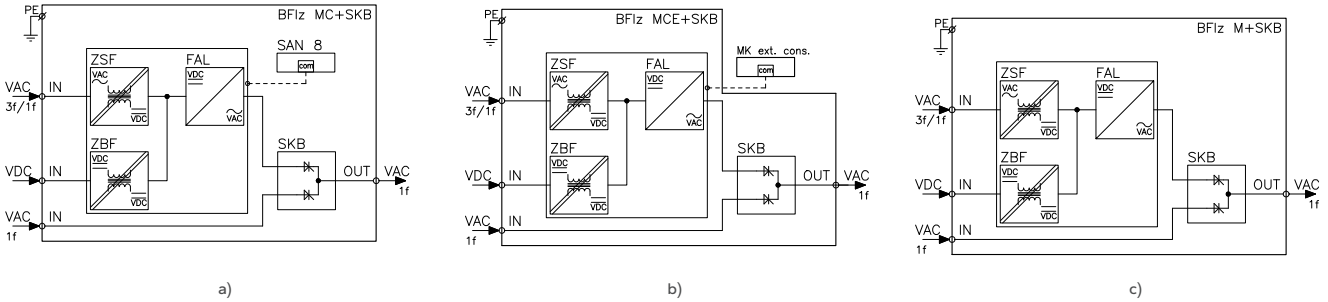
CUSTOM INVERTERS

In the case of atypical or special requirements related to the design, parameters of devices, formal requirements or standards applicable in a given region of the world. Inverters produced by APS Energia SA are designed in accordance with the project requirements. Special designs constitute a huge percent of solutions designed and manufactured by APS Energia SA.

MODULAR DESIGN INVERTERS

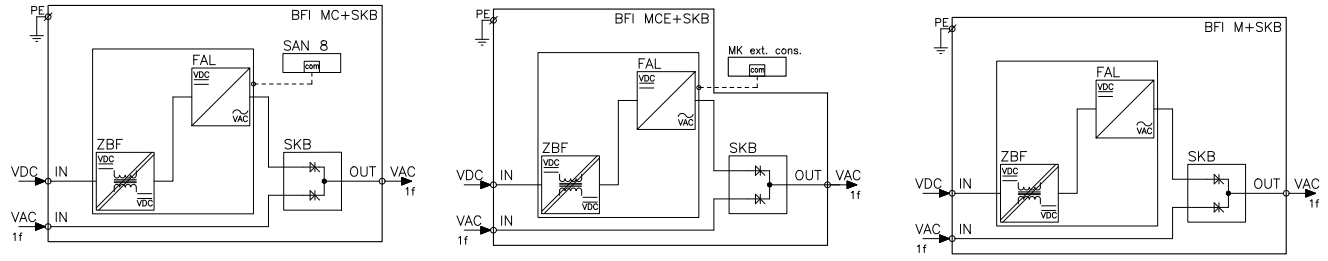
THE INVERTER MODULE INTENDED FOR AUTONOMOUS OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE.

This chapter presents single-phase type BFIz / BFI inverters in a form of 19" module of standard 6U height. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.



a) b) c)

Fig. 46 Block diagram of the BFIz type inverter module with a power supply unit and the SKB type bypass:
a) with a built-in console; b) with an external MK console; c) without a console.



a) b) c)

Fig. 47. Block diagram of the BFI type inverter module with the SKB bypass:
a) with a built-in console; b) with an external MK console; c) without a console.

The BFIz+SKB inverter module is supplied by the basic AC network voltage, the DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFI+SKB inverter module is supplied from the DC voltage and a reserve AC network voltage. By standard, the inverter module is equipped with a SAN 8 inverter operating parameters control system. Modules with a built-in SAN 8 console belong to the MC modules family.

(Fig. 46 a), modules with an external MK console belong to the MCE modules family (Fig. 46 b), while the modules without the SAN 8 console are a part of the M modules family (Fig. 46 c).

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of the value accordant with the order (by standard, 230 V AC). The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIz / BFI modules may be equipped with the SKB automatic bypass system.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION

Rated output voltage 230 V AC*

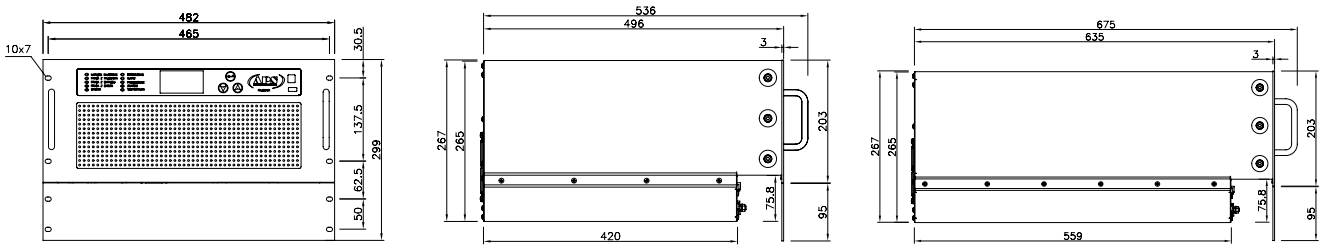
Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions****
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 MC**+SKB 1***	M5
		3×400 or 230	BFIz 1S 24/230 MC**+SKB 1***	
7.5	60	-	BFI 7.5S 60 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIz 1S 110 / 230 MC**+SKB 1***	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 MC**+SKB 3***	M5
		3×400 or 230	BFIz 3S 110 / 230 MC**+SKB 3***	
7.5 / 10		-	BFI 7.5S 110 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIz 1S 220 / 230 MC**+SKB 1***	
7.5 / 10		-	BFI 7.5S 220 / 230 MC**+SKB 7.5***	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 MC**+SKB 7.5***	
10		3×400	BFIz 10S 220 / 230 MC**+SKB 10***	

* – possible options: 220 / 230 / 240 V AC;

** – possible options: M / MC / MCE;

*** – a module without the SKB bypass is available as an option;

**** – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).



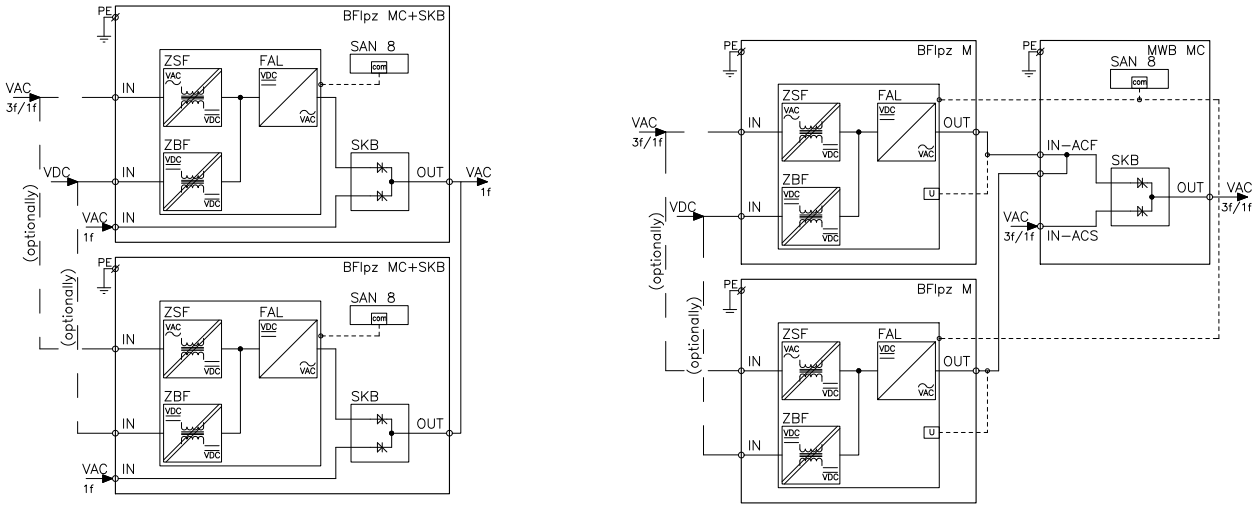
a) b) c)

Fig. 48. Views with dimensions of the BFIz / BFI type inverter module (option):
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

THE INVERTER MODULE INTENDED FOR PARALLEL OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE

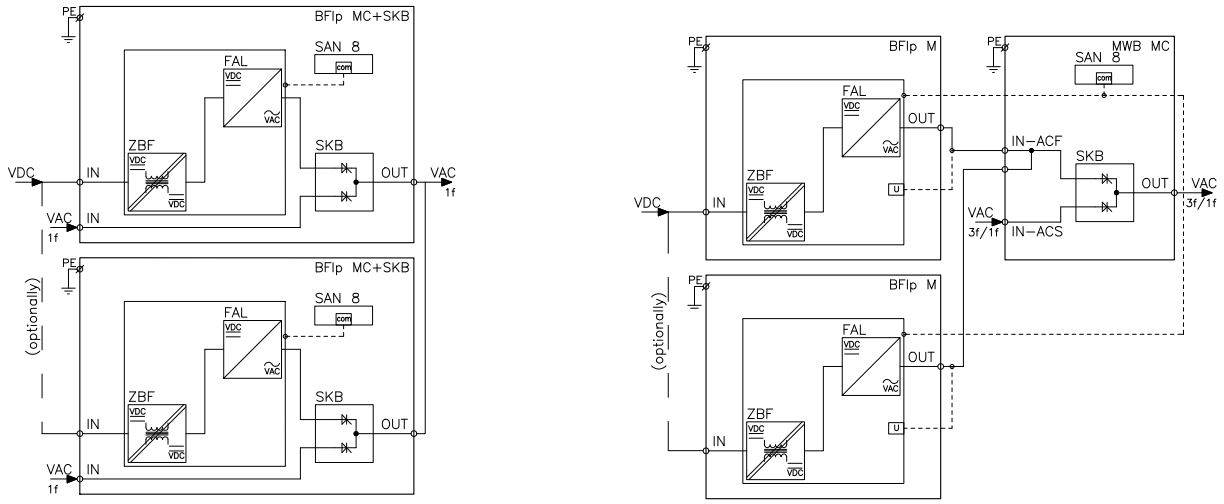
This chapter presents single-phase type BFIp / BFIpz inverters in a form of 19" module of standard 6U height. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIp / BFIpz inverter module is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.



a) b)

Fig. 49. Block diagram of the inverter module for parallel operation with the BFIpz power supply unit. Possible configurations:
a) two autonomous SKB type bypasses, a console built in the inverter module; b) a common SKB type bypass, a console built in the MWB module.



c) d)

Fig. 50. Block diagram of the BFIp type inverter module for parallel operation. Possible configurations:
a) two autonomous SKB type bypasses, a console built in the inverter module; b) a common SKB type bypass, a console built in the MWB module.

Systems consisting of two inverter modules operating in parallel are available in the following configurations:

1. Two modules – Fig. 49 a), Fig. 50 a):
   - Module 1 – inverter + automatic bypass:BFIpz / BFIp xxx MC + SKB
   - Module 2 – inverter + automatic bypass:BFIpz / BFIp xxx MC + SKB

2. Three modules – Fig. 49 b), Fig. 50b):
   - Module 1 – inverter 1: BFIpz / BFIp xxx M
   - Module 2 – inverter 2: BFIpz / BFIp xxx M
   - Module 3 – a module that integrates parallel operation of inverters + automatic bypass: MWB xx MC.

In configuration 1 – the BFIpz+SKB inverter module is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system) (Fig. 49 a). On the other hand, the BFIp+SKB inverter module is supplied from DC voltage and a reserve AC network voltage (Fig. 50 a).

In configuration 2 – the BFIpz inverter module is supplied by voltage of the basic AC network and DC voltage – Fig. 49 b), while the BFIp inverter module is supplied from DC voltage (Fig. 50 b). The MWB modules is supplied by voltage of the AC reserve network (the automatic bypass's supply voltage – this is a standard solution used to increase the system's reliability), as well as output voltages of inverters (Fig. 49 b, Fig. 50 b).

By standard, the module is equipped with the SAN 8 inverter operating parameters control system. Modules with a built-in SAN 8 console belong to the MC modules family.

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of value necessary according to the order. The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIp / BFIpz modules may be equipped with the SKB automatic bypass system.

Inverters and automatic bypasses in configuration 1 operate as MASTER / SLAVE, and do not require any additional synchronising systems.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES".

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION

Rated output voltage 230 V AC*

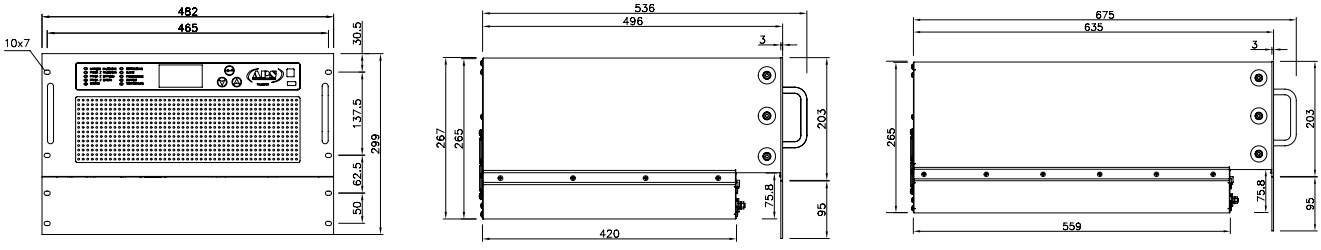
Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions****
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 MC**+SKB 1***	M5
		3×400 or 230	BFIpz 1S 24/230 MC**+SKB 1***	
7.5	60	-	BFIp 7.5S 60 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIpz 1S 110 / 230 MC**+SKB 1***	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 230 MC**+SKB 3***	M5
		3×400 or 230	BFIpz 3S 110 / 230 MC**+SKB 3***	
7.5 / 10		-	BFIp 7.5S 110 / 230 MC**+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 230 MC**+SKB 1***	M3
		3×400 or 230	BFIpz 1S 220 / 230 MC**+SKB 1***	
7.5 / 10		-	BFIp 7.5S 220 / 230 MC**+SKB 7.5***	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 MC**+SKB 7.5***	
10		3×400	BFIz 10S 220 / 230 MC**+SKB 10***	

* – possible options: 220 / 230 / 240 V AC;

** – possible options: M / MC / MCE;

*** – a module without the SKB bypass is available as an option;

**** – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).



a) b) c)

Fig. 51. Views with dimensions of the BFIpz / BFIp MC type inverter module (option):
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

THE INVERTER MODULE FOR AUTONOMOUS OPERATION WITH 50 Hz ISOLATING TRANSFORMER

This chapter presents the single-phase or three-phase BFIz / BFI type inverters in a form of 19" module of standard 6U height cooperating with 50 Hz isolating transformers. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIz / BFI inverter module cooperates with the MWB module and the transformer, which, apart from providing a galvanic isolation, also adapts the inverter module's output voltage to an appropriate value. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

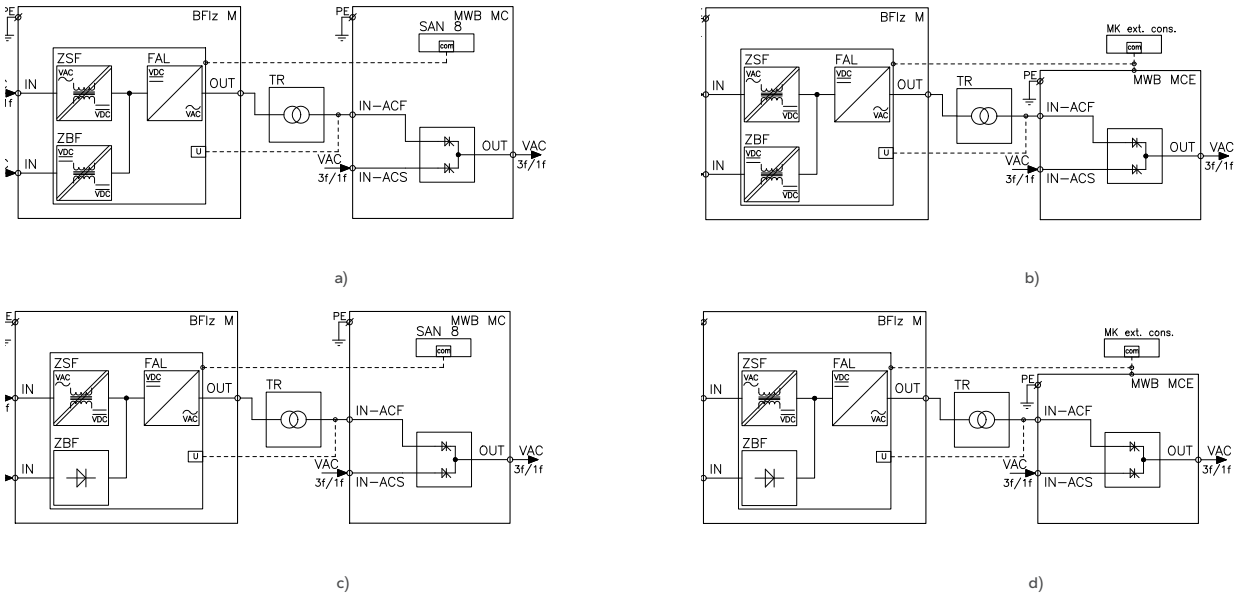


Fig. 52. Block diagram of the BFIz type inverter module with a power supply unit and the MWB module. Possible configurations:
a) power supply unit, battery converter, built-in console; b) power supply unit, battery converter, external MK console;
c) power supply unit, diode in the DC power supply circuit, built-in console; d) power supply unit, diode in the DC power supply circuit, external MK console.

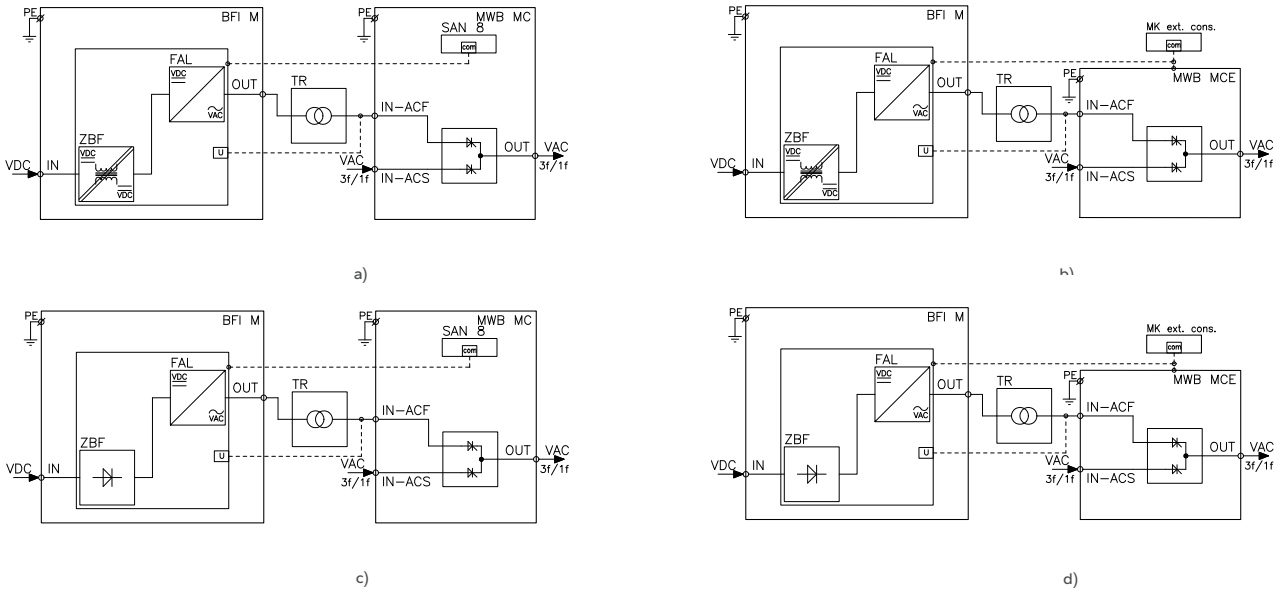


Fig. 53. Block diagram of the BFI type inverter module with the MWB module. Possible configurations:
a) battery converter, built-in console; b) battery converter, external MK console;
c) diode in the DC power supply circuit, built-in console; d) diode in the DC power supply circuit, external MK console.

The BFIz inverter module is supplied by voltage of the basic AC network and DC battery voltage (Fig. 52), while the BFI inverter module is supplied only by DC voltage (Fig. 53). The MWB module is supplied by voltage of the AC reserve network, as well as the inverter's output voltage adapted to the client's requirements by the transformer. This transformer provided isolation from supply voltage, and constitutes an ideal protection against penetration of the constant component to the loads in the case of a failure of the inverter. By standard, the MWB module is equipped with the SAN 8 inverter operating parameters control system. The MWB modules with a built-in console belong to the MC modules family, while the modules with an external MK console are a part of the MCE modules family. The BFIz / BFI modules without a controller belong to the M modules family.

The inverter's power supply (mains converter) converts the basic mains voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the mains from the inverter's circuits at the same time.

The battery power supply is available in two versions dependent on various parameters such as: overload, short-circuit, or the most important of those parameters: reliability.

1. High frequency DC/DC converter;
2. Cut-off diode.

1. The high frequency DC/DC converter (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

2. The diode is incorporated in series into the DC power supply circuit. The task of the diode is to provide DC power voltage to the inverter's circuits, and block penetration of the intermediate voltage of the inverter to DC supply voltage at the same time.

The system including a diode on the battery power supply circuit instead of a battery converter (Fig. 52 c, d, and Fig. 53 c, d) is characterised by a greater reliability due to a lack of processing on the DC circuit.

Due to the fact that the inverter in such a configuration is unable to autonomously obtain 230 V AC or 3×400 V AC rated voltage on its output, it always cooperates with the 50 Hz adapting transformer of appropriate voltage switch.

The galvanic isolation of the inverter and the basic AC power supply from DC voltage is ensured by a 50 Hz transformer (from the inverter's side) and a high-frequency transformer (at the side of the power supply unit).

The inverter converts direct current into alternating current adapted via the transformer to the value accordant with the order (by standard, 230 V or 3×400 V AC).

The MWB module may be equipped with the SKB automatic bypass system.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES".

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 230 V / 230 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 M	M5
		3×400 or 230	BFIz 1S 24/230 M	
7.5	60	-	BFI 7.5S 60 / 230 M	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 M	M3
		3×400 or 230	BFIz 1S 110 / 230 M	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 M	M5
		3×400 or 230	BFIz 3S 110 / 230 M	
7.5 / 10		-	BFI 7.5S 110 / 230 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 M	M3
		3×400 or 230	BFIz 1S 220 / 230 M	
7.5 / 10		-	BFI 7.5S 220 / 230 M	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 M	
10		3×400	BFIz 10S 220 / 230 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 115 V / 230 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/115 M	M5
		3×400 or 230	BFIz 1S 24/115 M	
7.5	60	-	BFI 7.5S 60 / 115 M	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 115 M	M3
		3×400 or 230	BFIz 1S 110 / 115 M	
3 / 3.5 / 5	110	-	BFI 3S 110 / 115 M	M5
		3×400 or 230	BFIz 3S 110 / 115 M	
7.5 / 10		-	BFI 7.5S 110 / 115 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 115 M	
		3×400 or 230	BFIz 1S 220 / 115 M	
7.5 / 10		-	BFI 7.5S 220 / 115 M	
7.5		3×400 or 230	BFIz 7.5S 220 / 115 M	
10		3×400	BFIz 10S 220 / 115 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×240 V / 3×400 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 3×240 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 /	24 / 48 / 60	-	BFI 1T 24/240 M	M5
		3×400 or 230	BFIz 1T 24/240 M	
7.5	60	-	BFI 7.5T 60 / 240 M	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 240 M	
		3×400 or 230	BFIz 1T 110 / 240 M	
3 / 3.5 / 5	110	-	BFI 3T 110 / 240 M	
		3×400 or 230	BFIz 3T 110 / 240 M	
7.5 / 10		-	BFI 7.5T 110 / 240 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 240 M	
		3×400 or 230	BFIz 1T 220 / 240 M	
7.5 / 10		-	BFI 7.5T 220 / 240 M	
7.5		3×400 or 230	BFIz 7.5T 220 / 240 M	
10		3×400	BFIz 10T 220 / 240 M	

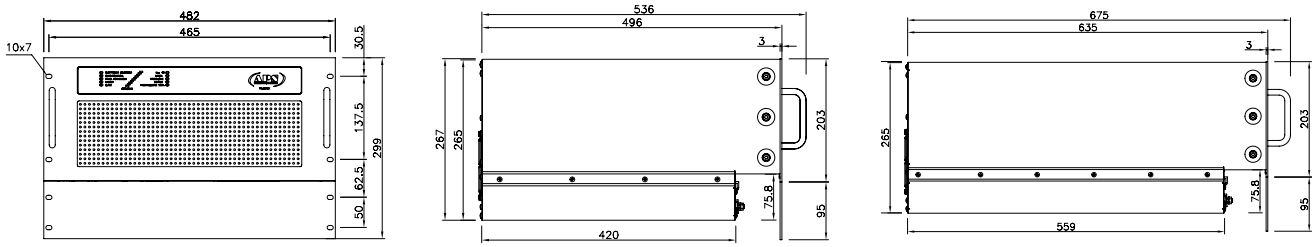
* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×110 V / 3×400 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 3×110 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/110 M	M5
		3×400 or 230	BFIz 1T 24/110 M	
7.5	60	-	BFI 7.5T 60 / 110 M	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 110 M	
		3×400 or 230	BFIz 1T 110 / 110 M	
3 / 3.5 / 5	110	-	BFI 3T 110 / 110 M	
		3×400 or 230	BFIz 3T 110 / 110 M	
7.5 / 10		-	BFI 7.5T 110 / 110 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 110 m	
		3×400 or 230	BFIz 1T 220 / 110 M	
7.5 / 10		-	BFI 7.5T 220 / 110 M	
7.5		3×400 or 230	BFIz 7.5T 220 / 110 M	
10		3×400	BFIz 10T 220 / 110 M	

* – M5 (6U): 482×267×635. (W×H×D).



a) b) c)

Fig. 54. Views with dimensions of the BFIz / BFI M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

THE INVERTER MODULE FOR PARALLEL OPERATION WITH 50 Hz ISOLATING TRANSFORMER

This chapter presents the single-phase or three-phase BFIpz / BFIp type inverters in a form of 19" module of standard 6U height cooperating with 50 Hz isolating transformers. They are adapted for mounting in industrial cabinets. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIpz / BFIp inverter module is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.

The BFIpz / BFIp M inverter modules cooperate with the MWB module and transformers, which, apart from providing galvanic isolation, also adapt output voltages of inverter modules to appropriate values. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

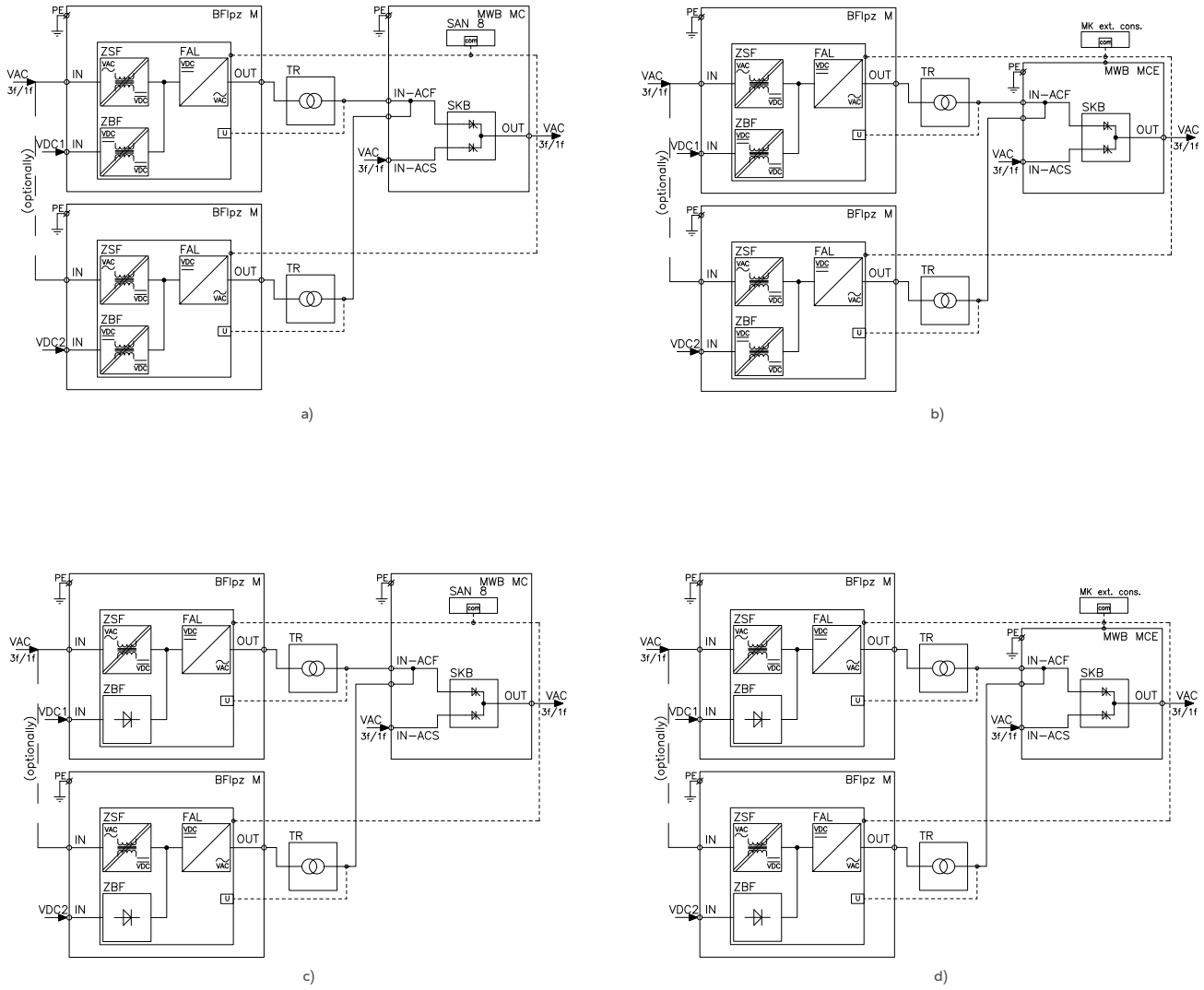


Fig. 55. Block diagram of the inverter modules for parallel operation with the BFIpz power supply unit and the MWB module. Possible configurations:
a) power supply unit, battery converter, built-in console; b) power supply unit, battery converter, external MK console;
c) power supply unit, diode in the DC power supply circuit, built-in console; d) power supply unit, diode in the DC power supply circuit, external MK console.

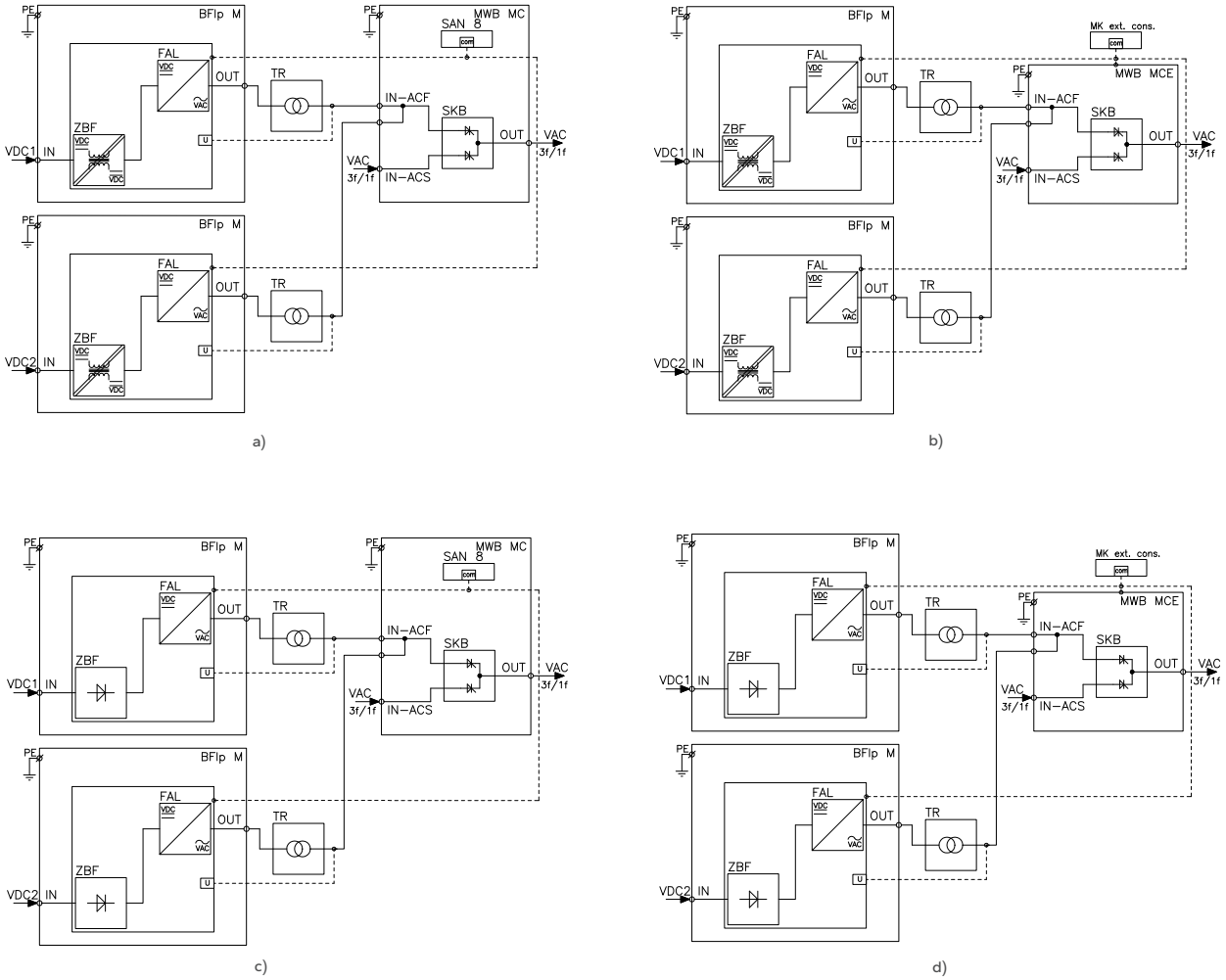


Fig. 56. Block diagram of the BFIp type inverter modules for parallel operation and the MWB module. Possible configurations:
a) battery power supply, built-in console; b) battery power supply, external MK console;
c) diode in the DC power supply circuit, built-in console; d) diode in the DC power supply circuit, external MK console.

The BFIpz inverter module is supplied by voltage of the basic AC network and DC battery voltage (Fig. 55), while the BFIp inverter module is supplied only by DC voltage (Fig. 56). The MWB module is supplied by the reserve AC network, and has two inputs to which output voltages (adapted to the client's requirements) of inverters are applied by transformers. The transformers provide isolation from supply voltages and constitute an ideal protection against penetration of the constant component to the loads in the case of a failure of the inverter. The MWB type inverters parallel operation integrating module is equipped with the SAN 8 system that controls the operating parameters of the inverters. The MWB module with a built-in console belong to the MC modules family (Fig. 56 a, c), while the modules with an external MK console are a part of the MCE modules family (Fig. 56 b, d). The BFIpz / BFIp modules without a controller belong to the M modules family.

The inverter's power supply (mains converter) converts the basic mains voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the mains from the inverter's circuits at the same time.

The battery power supply is available in two versions dependent on various parameters such as: overload, short-circuit, or the most important of those parameters: reliability.

1. High frequency DC/DC converter
   (Fig. 55 a, b, and Fig. 56 a, b);
2. Cut-off diode (Fig. 55 c, d, and Fig. 56 c, d).

1. The high frequency DC/DC converter (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

2. The diode is incorporated in series into the DC power supply circuit. The task of the diode is to provide DC power voltage to the inverter's circuits, and block penetration of the intermediate voltage of the inverter to DC supply voltage at the same time.

The system including a diode on the battery power supply circuit instead of a battery converter (Fig. 55 c, d, and Fig. 56 c, d) is characterised by a greater reliability due to a lack of processing on the DC circuit.

Due to the fact that the inverter in such a configuration is unable to autonomously obtain 230 V AC or 3×400 V AC rated voltage on its output, it always cooperates with the 50 Hz adapting transformer of appropriate voltage switch.

The galvanic isolation of the inverter and the basic AC power supply from DC voltage is ensured by a 50 Hz transformer (from the inverter's side) and a high-frequency transformer (at the side of the power supply unit).

The inverter converts direct current to alternating current adapted by the transformer to the value necessary according to the order.

The MWB module may be equipped with the SKB automatic bypass system.

Inverters in this configuration operate as MASTER / SLAVE, and do not require additional synchronising systems.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES."

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 230 V / 230 V 50 Hz – AS PER FIG. 55 A, B, AND FIG. 56 A, B

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 M	M5
		3×400 or 230	BFIpz 1S 24/230 M	
7.5	60	-	BFIp 7.5S 60 / 230 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 230 M	M3
		3×400 or 230	BFIpz 1S 110 / 230 M	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 230 M	M5
		3×400 or 230	BFIpz 3S 110 / 230 M	
7.5 / 10		-	BFIp 7.5S 110 / 230 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 230 M	M3
		3×400 or 230	BFIpz 1S 220 / 230 M	
7.5 / 10		-	BFIp 7.5S 220 / 230 M	M5
7.5		3×400 or 230	BFIpz 7.5S 220 / 230 M	
10		3×400	BFIpz 10S 220 / 230 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 1-PHASE TRANSFORMER 115 V / 230 V 50 Hz – AS PER FIG. 55 C, D, AND FIG. 56 C, D

Inverter module's rated output voltage – 115 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/115 M	M5
		3×400 or 230	BFIpz 1S 24/115 M	
7.5	60	-	BFIp 7.5S 60 / 115 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 115 M	M3
		3×400 or 230	BFIpz 1S 110 / 115 M	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 115 M	M5
		3×400 or 230	BFIpz 3S 110 / 115 M	
7.5 / 10		-	BFIp 7.5S 110 / 115 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 115 M	M5
		3×400 or 230	BFIpz 1S 220 / 115 M	
7.5 / 10		-	BFIp 7.5S 220 / 115 M	
7.5		3×400 or 230	BFIpz 7.5S 220 / 115 M	
10		3×400	BFIpz 10S 220 / 115 M	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×240 V / 3×400 V 50 Hz – AS PER FIG. 55 A, B, AND FIG. 56 A, B

Inverter module's rated output voltage – 3×240 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1T 24/240 M	M5
		3×400 or 230	BFIpz 1T 24/240 M	
7.5	60	-	BFIp 7.5T 60 / 240 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1T 110 / 240 M	
		3×400 or 230	BFIpz 1T 110 / 240 M	
3 / 3.5 / 5	110	-	BFIp 3T 110 / 240 M	
		3×400 or 230	BFIpz 3T 110 / 240 M	
7.5 / 10		-	BFIp 7.5T 110 / 240 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1T 220 / 240 M	
		3×400 or 230	BFIpz 1T 220 / 240 M	
7.5 / 10		-	BFIp 7.5T 220 / 240 M	
7.5		3×400 or 230	BFIpz 7.5T 220 / 240 M	
10		3×400	BFIpz 10T 220 / 240 M	

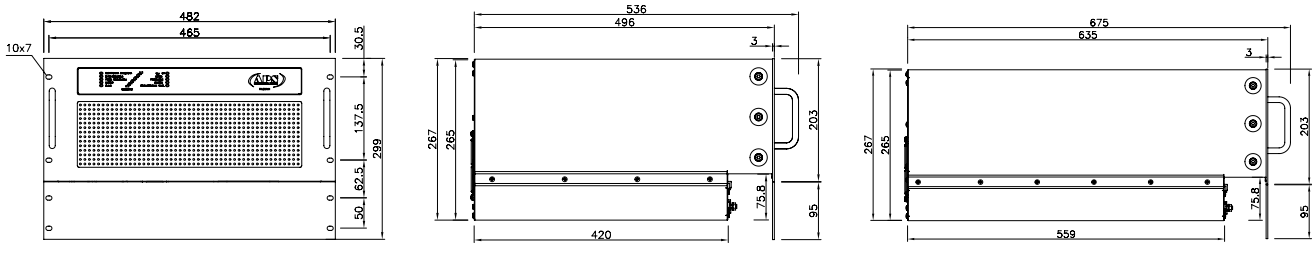
* – M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA FOR PARALLEL OPERATION IN COOPERATION WITH 3-PHASE TRANSFORMER 3×110 V / 3×400 V 50 Hz – AS PER FIG. 55 C, D, AND FIG. 56 C, D

Inverter module's rated output voltage – 3×110 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1T 24/110 M	M5
		3×400 or 230	BFIpz 1T 24/110 M	
7.5	60	-	BFIp 7.5T 60 / 110 M	
1 / 2 / 2.5	110 / 220	-	BFIp 1T 110 / 110 M	
		3×400 or 230	BFIpz 1T 110 / 110 M	
3 / 3.5 / 5	110	-	BFIp 3T 110 / 110 M	
		3×400 or 230	BFIpz 3T 110 / 110 M	
7.5 / 10		-	BFIp 7.5T 110 / 110 M	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1T 220 / 110 m	
		3×400 or 230	BFIpz 1T 220 / 110 M	
7.5 / 10		-	BFIp 7.5T 220 / 110 M	
7.5		3×400 or 230	BFIpz 7.5T 220 / 110 M	
10		3×400	BFIpz 10T 220 / 110 M	

* – M5 (6U): 482×267×635. (W×H×D).

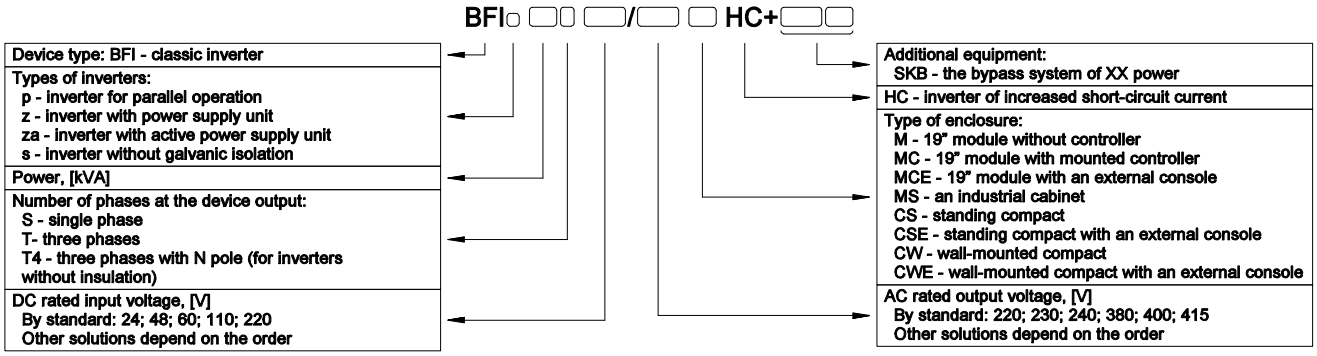


a) b) c)

Fig. 57. Views with dimensions of the BFIpz / BFIp M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

INVERTER MODULE OF INCREASED SHORT-CIRCUIT CURRENT

METHOD OF DESIGNATION OF THE BFI HC TYPE INVERTERS OF INCREASED SHORT-CIRCUIT



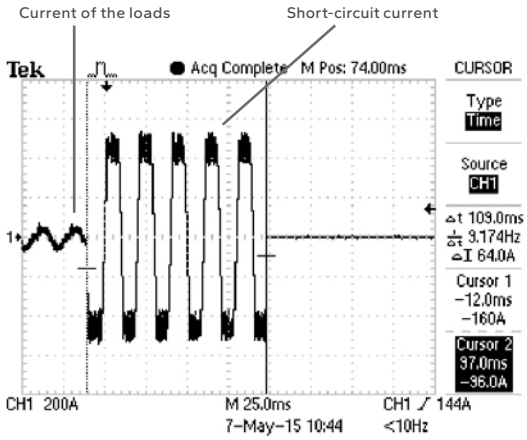
The HC version BFIz / BFI inverter modules create a family of devices, which, contrary to standard inverter modules, are characterised by increased operating parameters:

- higher multiplication crest factor (from 3:1 to 5:1),
- high short-circuit currents at the inverter's output (3×In to 9×In).

Significantly higher-than-standard short-circuit current parameters ensure highly selective tripping of protection in inverter-supplied distribution board. A high resistance to overload characteristic for the HC inverters is useful when supplying loads of high starting currents (e.g., electric motors) without increasing the power of the inverter itself, thus reducing the costs and impacting the overall dimensions of the inverter. High crest factor is particularly important in the case of supplying pulse loads.

The BFIz / BFI / BFIpz / BFIp HC inverter module may cooperate with the MWB module and transformer to provide galvanic isolation and adapt the inverter module output voltage to an appropriate value. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

Note: the MWB type bypass system module is described in chapter "MODULAR DESIGN STATIC SWITCHES."



Oscillogram of the programmed current and the duration of short-circuit of the inverter

SERIES TYPE: 1-PHASE HC INVERTER MODULES 1 ÷ 10kVA

Rated output voltage 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions****
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 MC** HC +SKB 1***	M5
		3×400 or 230	BFIz 1S 24/230 MC** HC+SKB 1***	
7.5	60	-	BFI 7.5S 60 / 230 MC** HC+SKB 7.5***	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 MC** HC+SKB 1***	M3
		3×400 or 230	BFIz 1S 110 / 230 MC** HC+SKB 1***	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 MC** HC+SKB 3***	M5
		3×400 or 230	BFIz 3S 110 / 230 MC** HC+SKB 3***	
7.5 / 10		-	BFI 7.5S 110 / 230 MC** HC+SKB 7.5***	
3 / 3.5 / 5	220	-	BFI 3S 220 / 230 MC** HC+SKB 3***	M3/M5*****
		3×400 or 230	BFIz 3S 220 / 230 MC** HC+SKB 3***	
7.5 / 10		-	BFI 7.5S 220 / 230 MC** HC+SKB 7.5***	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 MC** HC+SKB 7.5***	
10		3×400	BFIz 10S 220 / 230 MC** HC+SKB 10***	

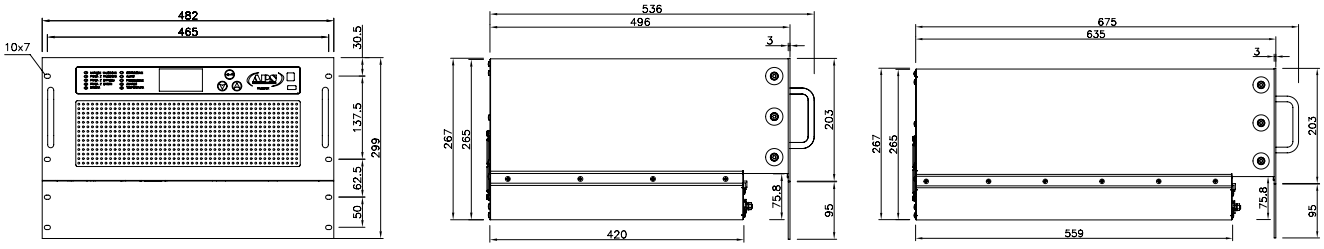
* – possible options: 220 / 230 / 240 V AC;

** – possible options: M / MC / MCE;

*** – a module without the SKB bypass is available as an option;

**** – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D);

***** – M3 or M5 module, depending on the short-circuit current value



a) b) c)

Fig. 58. Views with dimensions of the BFIz / BFI MC HC type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 1-PHASE TRANSFORMER 230 V / 230 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 230 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 M HC	M5
		3×400 or 230	BFIz 1S 24/230 M HC	
7.5	60	-	BFI 7.5S 60 / 230 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 M HC	M3
		3×400 or 230	BFIz 1S 110 / 230 M HC	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 M HC	M5
		3×400 or 230	BFIz 3S 110 / 230 M HC	
7.5 / 10		-	BFI 7.5S 110 / 230 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 M HC	M3
		3×400 or 230	BFIz 1S 220 / 230 M HC	
7.5 / 10		-	BFI 7.5S 220 / 230 M HC	M5
7.5		3×400 or 230	BFIz 7.5S 220 / 230 M HC	
10		3×400	BFIz 10S 220 / 230 M HC	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 1-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 1-PHASE TRANSFORMER 115 V / 230 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 115 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/115 M HC	M5
		3×400 or 230	BFIz 1S 24/115 M HC	
7.5	60	-	BFI 7.5S 60 / 115 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 115 M HC	M3
		3×400 or 230	BFIz 1S 110 / 115 M HC	
3 / 3.5 / 5	110	-	BFI 3S 110 / 115 M HC	M5
		3×400 or 230	BFIz 3S 110 / 115 M HC	
7.5 / 10		-	BFI 7.5S 110 / 115 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 115 M HC	M5
		3×400 or 230	BFIz 1S 220 / 115 M HC	
7.5 / 10		-	BFI 7.5S 220 / 115 M HC	
7.5		3×400 or 230	BFIz 7.5S 220 / 115 M HC	
10		3×400	BFIz 10S 220 / 115 M HC	

* – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 3-PHASE TRANSFORMER 3×240 V / 3×400 V 50 Hz – AS PER FIG. 52 A, B, AND FIG. 53 A, B

Inverter module's rated output voltage – 3×240 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/240 M HC	M5
		3×400 or 230	BFIz 1T 24/240 M HC	
7.5	60	-	BFI 7.5T 60 / 240 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 240 M HC	
		3×400 or 230	BFIz 1T 110 / 240 M HC	
3 / 3.5 / 5	110	-	BFI 3T 110 / 240 M HC	
		3×400 or 230	BFIz 3T 110 / 240 M HC	
7.5 / 10		-	BFI 7.5T 110 / 240 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 240 M HC	
		3×400 or 230	BFIz 1T 220 / 240 M HC	
7.5 / 10		-	BFI 7.5T 220 / 240 M HC	
7.5		3×400 or 230	BFIz 7.5T 220 / 240 M HC	
10		3×400	BFIz 10T 220 / 240 M HC	

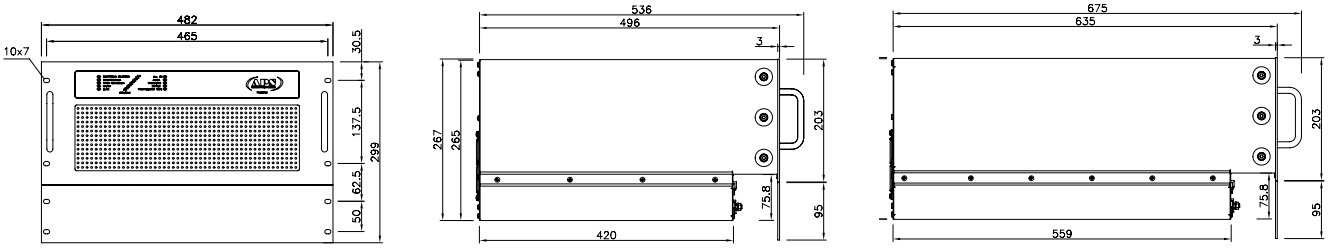
* – M5 (6U): 482×267×635. (W×H×D).

SERIES TYPE: 3-PHASE INVERTER MODULES 1 ÷ 10kVA IN COOPERATION WITH 3-PHASE TRANSFORMER 3×110 V / 3×400 V 50 Hz – AS PER FIG. 52 C, D, AND FIG. 53 C, D

Inverter module's rated output voltage – 3×110 V AC

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions*
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/110 M HC	M5
		3×400 or 230	BFIz 1T 24/110 M HC	
7.5	60	-	BFI 7.5T 60 / 110 M HC	
1 / 2 / 2.5	110 / 220	-	BFI 1T 110 / 110 M HC	
		3×400 or 230	BFIz 1T 110 / 110 M HC	
3 / 3.5 / 5	110	-	BFI 3T 110 / 110 M HC	
		3×400 or 230	BFIz 3T 110 / 110 M HC	
7.5 / 10		-	BFI 7.5T 110 / 110 M HC	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1T 220 / 110 m HC	
		3×400 or 230	BFIz 1T 220 / 110 M HC	
7.5 / 10		-	BFI 7.5T 220 / 110 M HC	
7.5		3×400 or 230	BFIz 7.5T 220 / 110 M HC	
10		3×400	BFIz 10T 220 / 110 M HC	

* – M5 (6U): 482×267×635. (W×H×D).



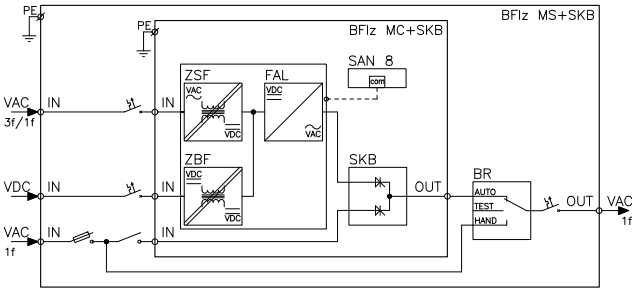
a) b) c)

Fig. 59. Views with dimensions of the BFIz / BFI M type inverter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

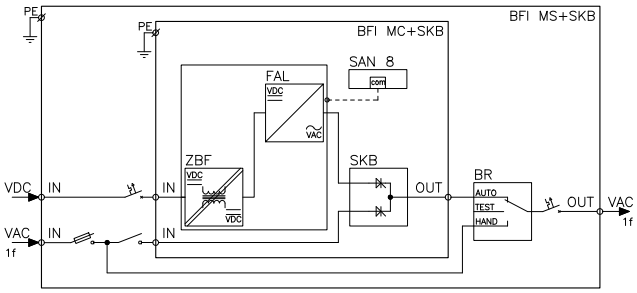
INVERTERS BUILT IN A CABINET

THE INVERTER CABINET FOR AUTONOMOUS OPERATION

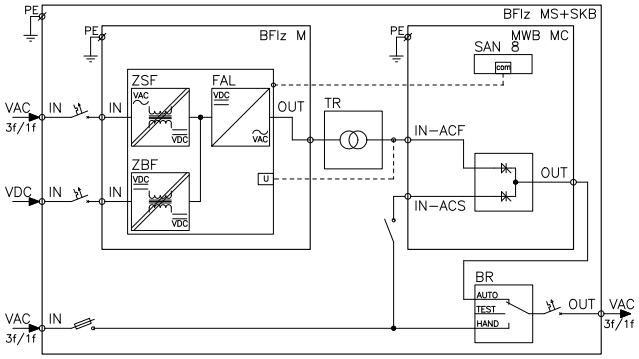
This chapter presents the BFIz / BFI type inverters in a form of 19" industrial cabinet for installation on a substrate. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.



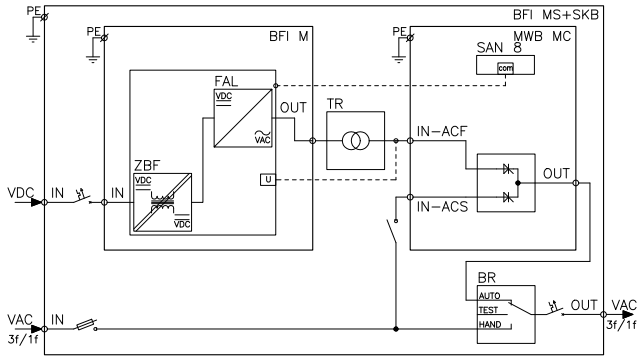
a)



b)



c)



d)

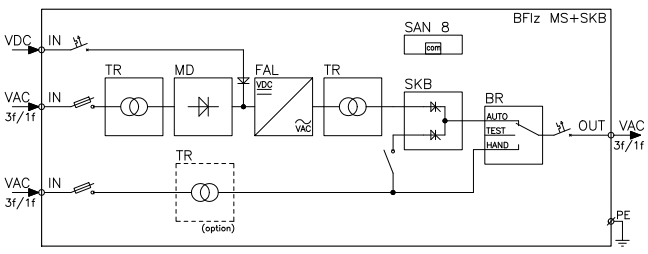
Fig. 60 a) and b) present a standard solution for single-phase module inverters in an industrial cabinet.

Description of the inverter module is provided in chapter "The inverter module intended for autonomous operation with galvanic isolation at the AC and DC supply voltage side."

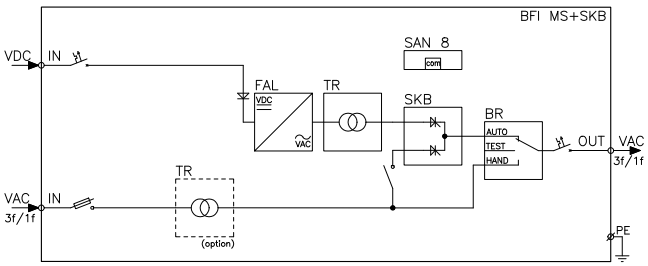
Fig. 60 c) and d) present a standard solution for single-phase or three-phase module inverters with a 50 Hz transformer in an industrial cabinet.

Description of the inverter module is provided in chapter "The inverter module for autonomous operation with a 50 Hz isolating transformer."

Fig. 60. Block diagram of a cabinet with an inverter module:
a) the BFIz type with the SKB bypass; b) the BFI type with the SKB bypass;
c) the BFIz type with a 50 Hz transformer and the MWB module; d) the BFI type with a 50 Hz transformer and the MWB module.



a)



b)

Fig. 61. Block diagram of the inverter cabinet in a free design:
a) the BFIz type with the SKB bypass; b) the BFI type with the SKB bypass.

Fig. 61 a) and b) present a standard solution for single-phase or three-phase inverters in a free design in an industrial cabinet.

The BFIz+SKB inverter cabinet is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFI+SKB inverter cabinet is supplied from DC voltage and a reserve AC network voltage. By standard, the inverter cabinet is equipped with the SAN 8 inverter operating parameters control system.

Fig. 61 a) presents an inverter with a power supply unit consisting of a 12-impulse transformer and a 12-impulse diode rectifier. Application of the transformer ensures galvanic isolation of DC supply voltage from the AC network, and adapts the AC supply to the needs of the inverter, which depend on the value of the DC power supply. The 12-impulse transformer may also be used to improve the THD value of the current drawn from the mains. Application of a diode rectifier significantly increases reliability of the power supply and desensitises the inverter to any disturbances in the voltage or the frequency of the mains. Apart from the diode, there are no automatics or power electronics elements in the DC power supply circuit, which guarantees certain and continuous switch of the inverter to battery operation in the case of drop or break of the mains.

The inverter converts direct current into alternating current adapted via the transformer to the value accordant with the order (by standard, 230 V or 3×400 V AC).

The BFIz / BFI systems installed in cabinets may be equipped with the SKB automatic bypass system.

The industrial cabinet is cooled by a forced air circulation via redundant roof fans. Moreover, each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

ADDITIONAL OPTIONS

- Active power supply (sinusoidal current draw);
- Active filter in the AC power supply (improves THDi);
- Automatic bypass;
- Maintenance bypass;
- ATSE (duplex AC power supply);
- Isolating transformer in the bypass circuit;
- Cable entry from the top;
- Special designs – upon agreement;
- Built-in output circuits distribution board – upon agreement;
- High IP.

SERIES TYPE: 1-PHASE INVERTER CABINETS 1 ÷ 150kVA FOR AUTONOMOUS OPERATION

Rated output voltage 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIz 1S 24/230 MS+SKB 1***	
7.5 / 10	60	-	BFI 7.5S 60 / 230 MS+SKB 7.5***	
		3×400 or 230	BFIz 7.5S 60 / 230 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20	110 / 220	-	BFI 1S 110 / 230 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIz 1S 110 / 230 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIz 12.5S 110 / 230 MS+SKB 12.5***	
25 / 30 / 40	110	-	BFI 25S 110 / 230 MS+SKB 25***	1,200×800×2,000
		3×400	BFIz 25S 110 / 230 MS+SKB 25***	
50 / 60		-	BFI 50S 110 / 230 MS+SKB 50***	1,800×800×2,000
		3×400	BFIz 50S 110 / 230 MS+SKB 50***	
25 / 30 / 40	220	-	BFI 25S 220 / 230 MS+SKB 25***	600×800×2,000
		3×400	BFIz 25S 220 / 230 MS+SKB 25***	800×800×2,000
50 / 60 / 75		-	BFI 50S 220 / 230 MS+SKB 50****	1,200×800×2,000
		3×400	BFIz 50S 220 / 230 MS+SKB 50***	1,400×800×2,000
100 / 120		-	BFI 100S 220 / 230 MS+SKB 100***	1,800×800×2,000
		3×400	BFIz 100S 220 / 230 MS+SKB 100***	
140 / 150		-	BFI 140S 220 / 230 MS+SKB 140***	2,400×800×2,000
		3×400	BFIz 140S 220 / 230 MS+SKB 140***	

* – possible options: 220 / 230 / 240 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm;

*** – a cabinet without the SKB bypass is available as an option;

SERIES TYPE: 3-PHASE INVERTER CABINETS 1 ÷ 400kVA FOR AUTONOMOUS OPERATION

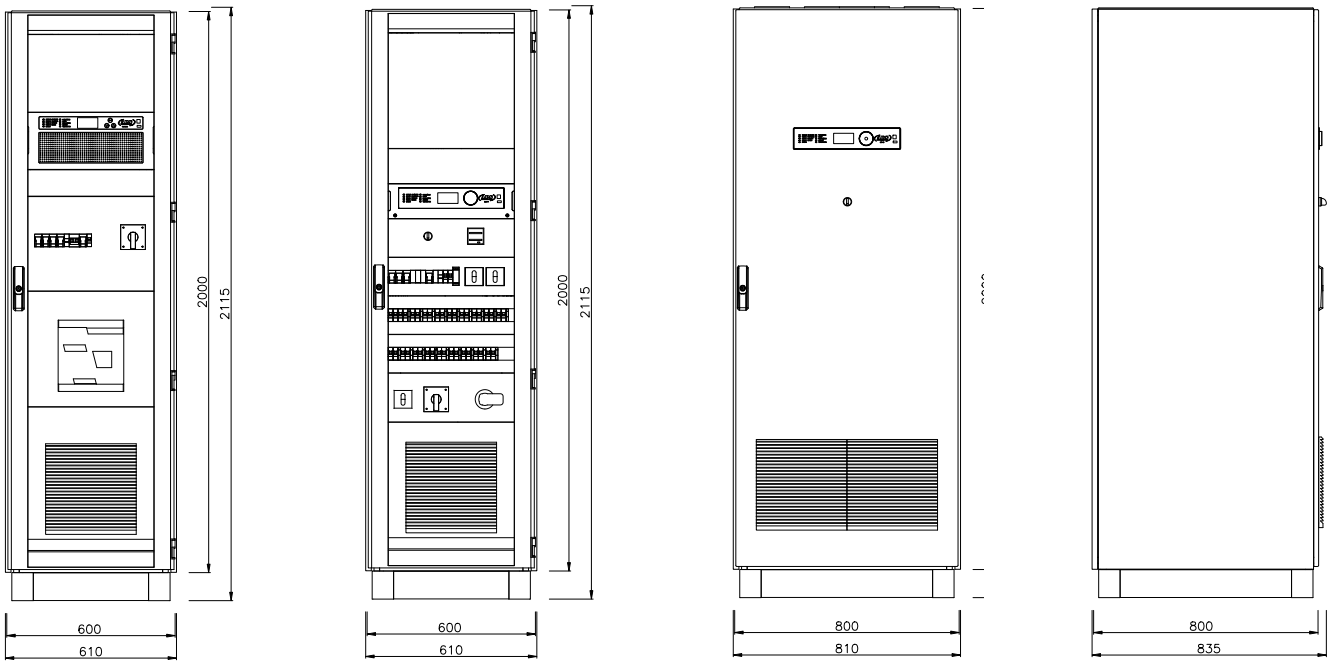
Rated output voltage 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1T 24/400 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIz 1T 24/400 MS+SKB 1***	
7.5 / 10	60	-	BFI 7.5T 60 / 400 MS+SKB 7.5***	
		3×400 or 230	BFIz 7.5T 60 / 400 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20 / 25 / 30 / 35 / 40	110 / 220	-	BFI 1T 110 / 400 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIz 1T 110 / 400 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIz 12.5T 110 / 400 MS+SKB 12.5***	
25 / 30 / 35 / 40		3×400	BFIz 25T 110 / 400 MS+SKB 25***	800×800×2,000
50 / 60 / 75	110	-	BFI 50T 110 / 400 MS+SKB 50***	1,200×800×2,000
		3×400	BFIz 50T 110 / 400 MS+SKB 50***	1,400×800×2,000
50 / 60	220	-	BFI 50T 220 / 400 MS+SKB 50***	600×800×2,000
50		3×400	BFIz 50T 220 / 400 MS+SKB 50***	800×800×2,000
75		-	BFI 75T 220 / 400 MS+SKB 75***	
60 / 75		3×400	BFIz 60T 220 / 400 MS+SKB 60***	1,400×800×2,000
100 / 120 / 140 / 150		-	BFI 100T 220 / 400 MS+SKB 100***	1,200×800×2,000
100 / 120		3×400	BFIz 100T 220 / 400 MS+SKB 100***	1,600×800×2,000
160		-	BFI 160T 220 / 400 MS+SKB 160***	1,400×800×2,000
140 / 150 / 160		3×400	BFIz 140T 220 / 400 MS+SKB 140***	2,000×800×2,000
180 / 200		-	BFI 180T 220 / 400 MS+SKB 180***	1,800×800×2,000
180 / 200 / 220 / 250		3×400	BFIz 180T 220 / 400 MS+SKB 180***	3,000×800×2,000
220 / 250		-	BFI 220T 220 / 400 MS+SKB 220***	2,000×800×2,000
300 / 350		-	BFI 300T 220 / 400 MS+SKB 300***	3,000×800×2,000
300		3×400	BFIz 300T 220 / 400 MS+SKB 300***	3,600×800×2,000
400		-	BFI 400T 220 / 400 MS+SKB 400***	3,200×800×2,000

* – possible options: 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm;

*** – a cabinet without the SKB bypass is available as an option;



a) b) c) d)

Fig. 62. Views with dimensions of the BFIz / BFI type inverter cabinet:
a) 600×800×2,000 cabinet (modular design) – front view; b) 600×800×2,000 cabinet (free design) – front view;
c) 800×800×2,000 cabinet (free design) – front view; d) cabinet of depth of 800 mm – left-side view.

THE INVERTER CABINET FOR PARALLEL OPERATION

This chapter presents the BFIpz / BFIp type inverters in a form of 19" industrial cabinet. They are intended for installation on a substrate. The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIpz / BFIp inverter is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.

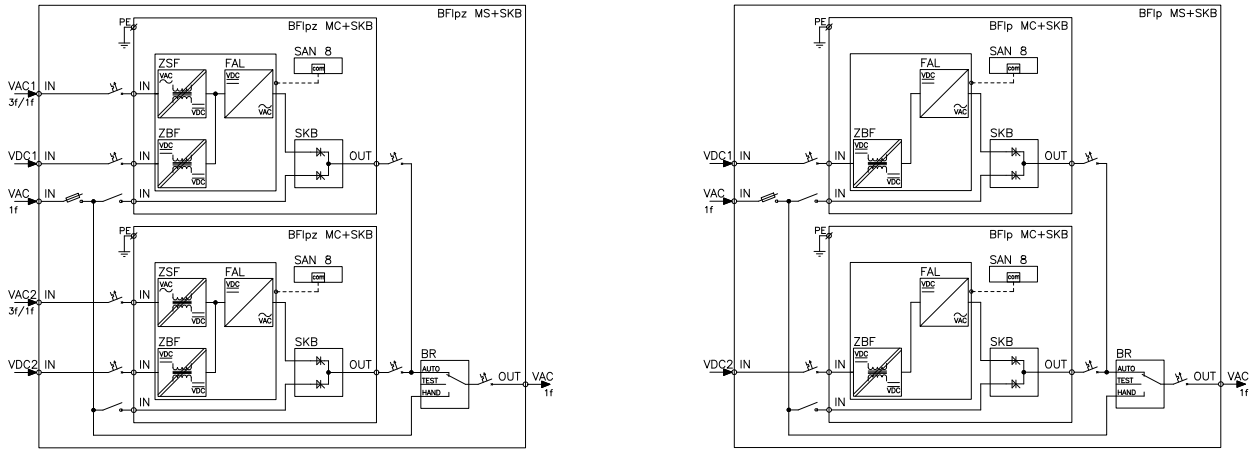


Fig. 63. Block diagram of the inverter cabinet consisting of the BFIpz/BFIp type inverter modules for parallel operation of max. module power up to 10kVA with the SKB type bypass (1-phase solution). Possible configurations:
a) a system of two BFIpz modular inverters with own bypasses; b) a system of two BFIp modular inverters with own bypasses.

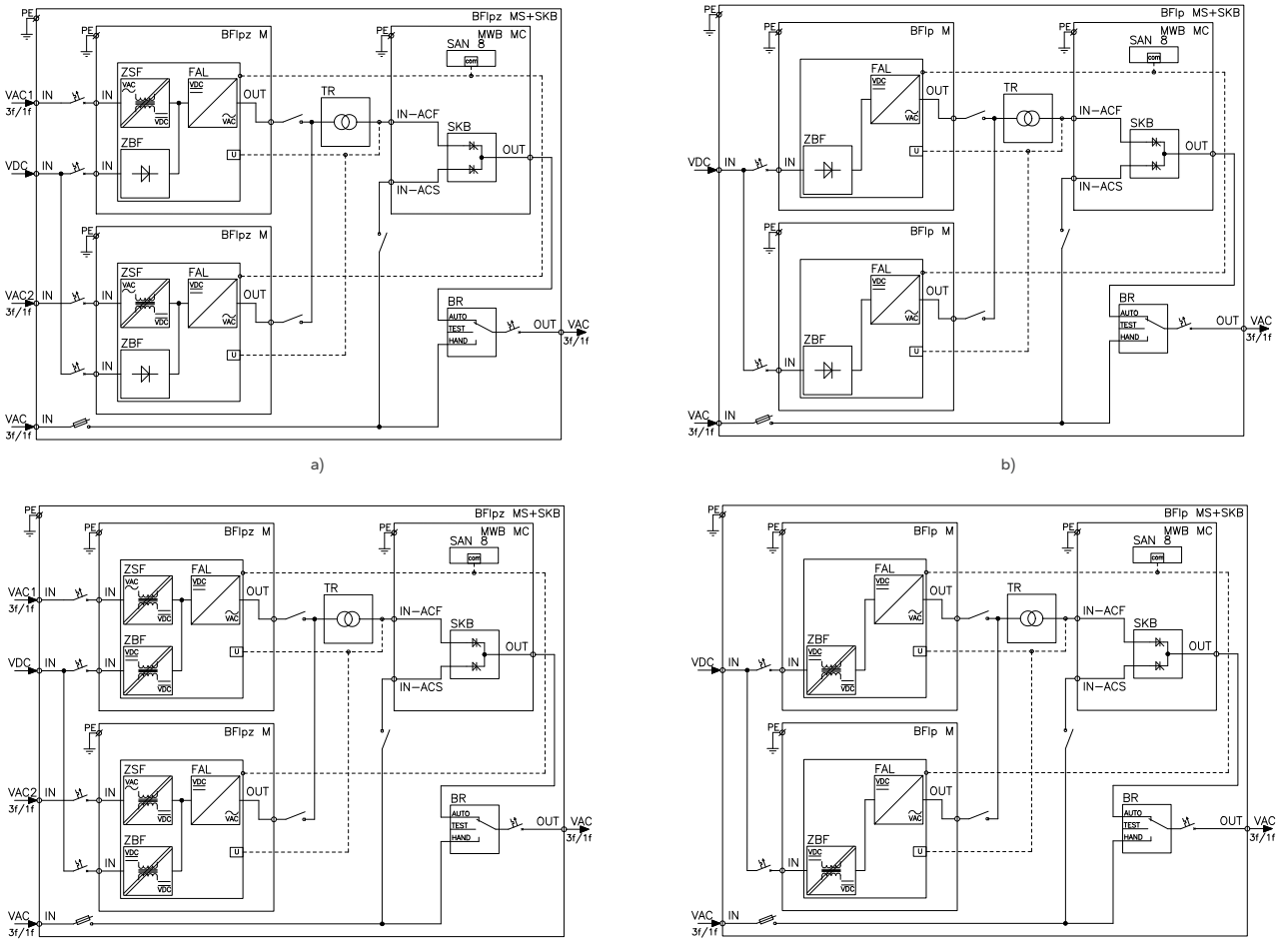


Fig. 64. Block diagram of the inverter cabinet consisting of the BFIpz / BFIp type inverter modules for parallel operation of max. module power up to 10kVA with the SKB type bypass and a common transformer (1-phase or 3-phase solution). Possible configurations:
a) a diode in the DC power supply circuit of the BFIpz type inverter module; b) a diode in the DC power supply of the BFIp type inverter module; c) a battery converter at the DC power supply of the BFIpz type inverter module; d) a battery converter at the DC power supply of the BFIp inverter module.

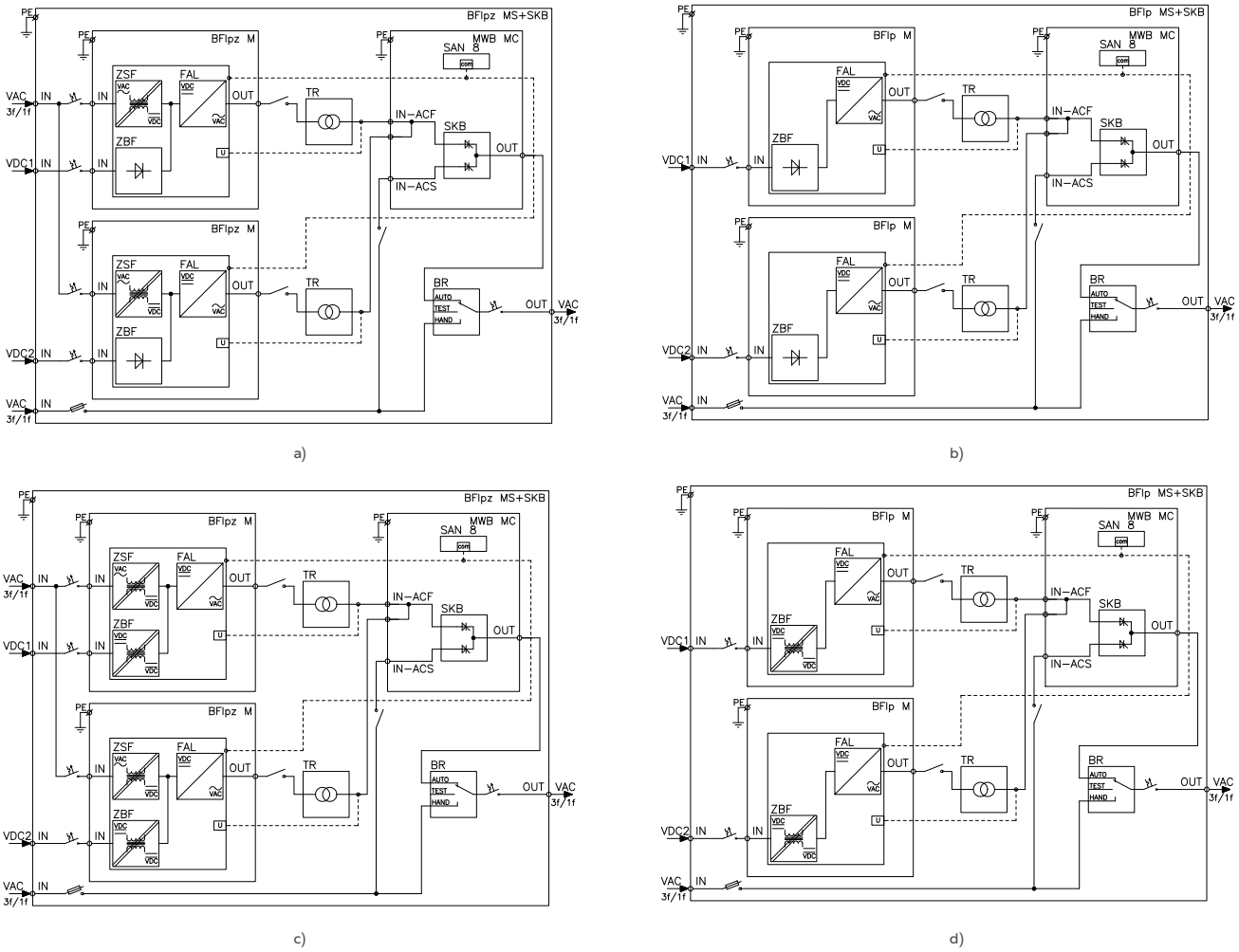


Fig. 65. Block diagram of the inverter cabinet consisting of the BFIpz / BFIp type inverter modules for parallel operation of max. module power up to 10kVA with the SKB type bypass and own transformers (1-phase or 3-phase solution). Possible configurations:

a) a diode in the DC power supply circuit of the BFIpz type inverter module; b) a diode in the DC power supply of the BFIp type inverter module;
c) a battery converter at the DC power supply of the BFIpz type inverter module; d) a battery converter at the DC power supply of the BFIp inverter module.

Fig. 63 – Fig. 66 present standard solutions for parallel operation of single-phase or three-phase modular inverters incorporated in industrial cabinets. The cabinet, which consists of inverter modules operating in parallel, is available in the following configurations:

1. Two modules – Fig. 63:

- Module 1 and Module 2 – inverter + automatic bypass:BFIpz / BFIp xxx MC + SKB
  Maximum power of the inverter module: 10kVA.

2. Three modules – Fig. 64, Fig. 65:

- Module 1 and Module 2 – inverter: BFIpz / BFIp xxx M
- Module 3 – a module that integrates parallel operation of inverters + automatic bypass: MWB xx MC
  Maximum power of a single inverter module: 10kVA.

3. "n" modules – Fig. 66:

- Module from 1 to "n" – inverter: BFIpz / BFIp xxx M
- The SKB automatic bypass system
  Maximum power of a single inverter module: 15kVA.Maximum number of modules for parallel operation: "n" = 16.

In configuration 1 – the BFIpz+SKB inverter module is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). The BFIp+SKB inverter module is supplied from DC voltage and a reserve AC network voltage.

Inverters and automatic bypasses in configuration 1 operate as MASTER / SLAVE, and do not require any additional synchronising systems.

In configuration 2 and 3 – the BFIpz inverter module is supplied from the basic AC network voltage and the DC voltage. On the other hand, the BFIp inverter module is supplied by the DC voltage. The SKB bypass in the MWB module (Fig. 64, Fig. 65) and the SKB bypass (Fig. 66) are supplied from the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to improve the reliability of the system), as well as output voltages of the inverters.

The cabinet (or module) is equipped with the SAN 8 inverter operating parameters control system.

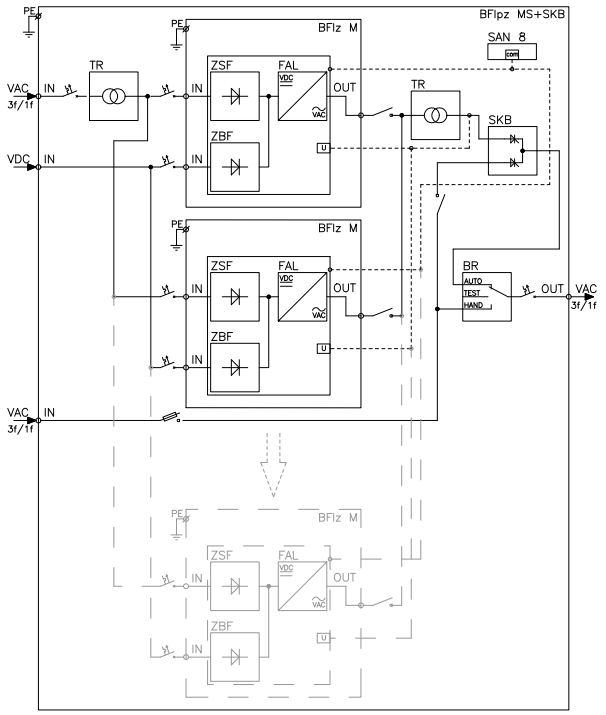


Fig. 66. Block diagram of the inverter cabinet consisting of the BFIpz type inverter modules for parallel operation of max. module power up to 15kVA with the SKB type bypass.

A system with "n" module inverters with a common bypass (1-phase or 3-phase solutions).

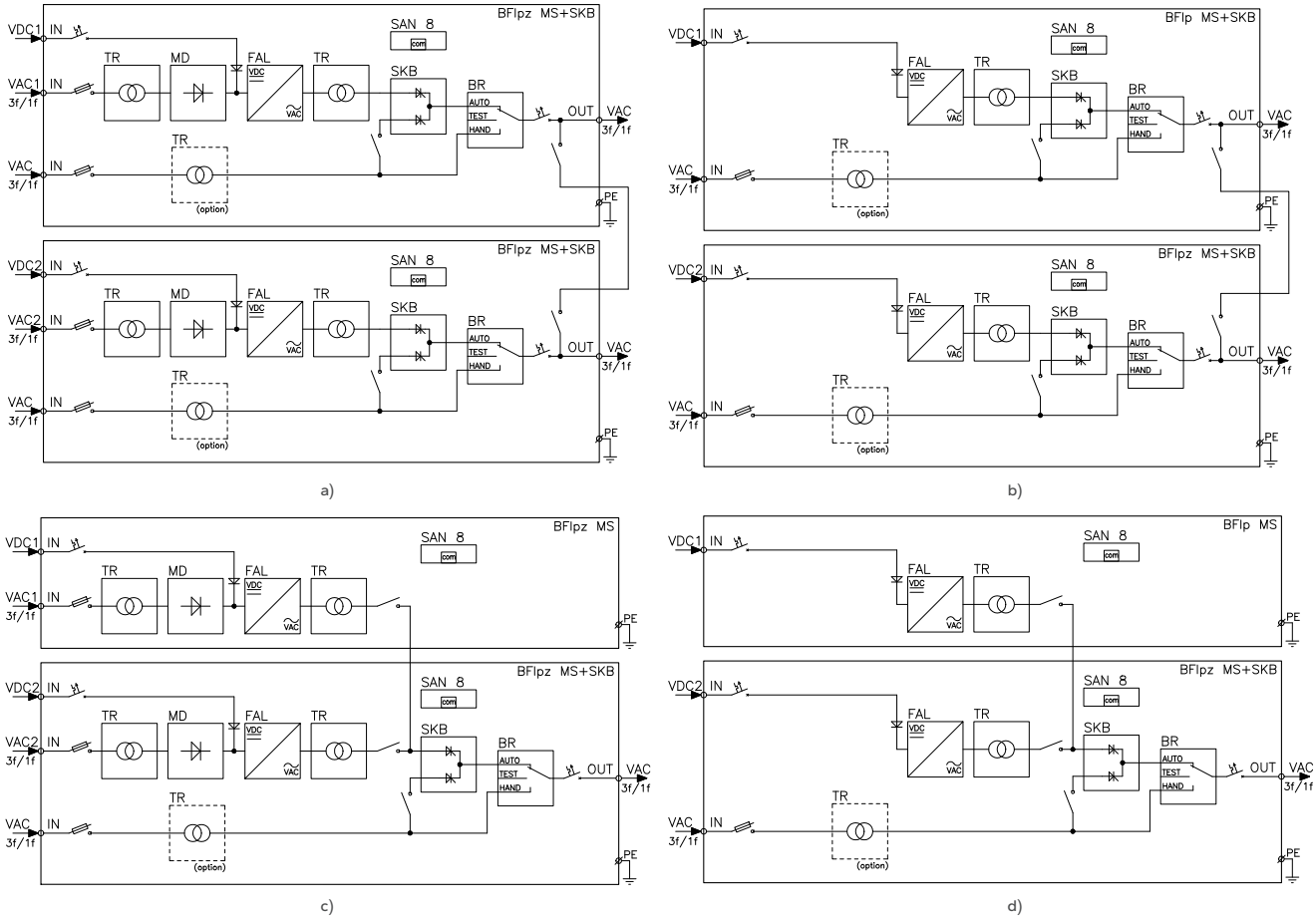


Fig. 67. Block diagram of the BFIpz / BFIp type inverter cabinets in a free design for parallel operation with the SKB type bypass. Possible configurations:
a) a parallel system of two BFIpz inverters with own bypasses; b) a parallel system of two BFIp inverters with own bypasses;
c) a parallel system of two BFIpz inverters with a single common bypass; d) a parallel system of two BFIp inverters with a single common bypass.

The inverter's power supply (mains and battery) is available in two versions dependent on various parameters such as: overload, short-circuit, or the most important of those parameters: reliability.

a) High-frequency converter (AC/DC for the power supply unit and DC/DC for the battery power supply);

b) Cut-off diode.

a.1. The high-frequency AC/DC converter (mains converter) transforms the AC supply voltage into direct voltage necessary to supply the inverter, and provided galvanic isolation of the mains from the inverter's circuits at the same time (Fig. 63 a; Fig. 64 a, c; Fig. 65 a, c).

a.2. The high frequency DC/DC converter (battery converter) transforms the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time (Fig. 63; Fig. 64 c, d; Fig. 65 c, d).

b.1. The diode is incorporated in series into the DC power supply circuit. The task of the diode is to provide DC power voltage to the inverter's circuits, and block penetration of the intermediate voltage of the inverter to DC supply voltage at the same time (Fig. 64 a, b; Fig. 65 a, b; Fig. 66).

b.2. The diode is incorporated in series into the AC power supply circuit. The task of the diode is to convert the AC power voltage to the DC voltage and feed it to the inverter's circuits, and preventing the intermediate voltage of the inverter from penetrating into the AC power supply at the same time (Fig. 66).

A system having a cut-off diode instead of the converter (Fig. 64 a, b; Fig. 65 a, b; Fig. 66) in the power circuit is characterised by a greater reliability due to the lack of processing in the AC and DC circuits.

Due to the fact that the inverter in the configuration presented in Fig. 64 – Fig. 66 is unable to autonomously obtain 230 V AC or 3×400 V AC rated voltage on its output, it always cooperates with a 50 Hz adapting transformer of appropriate voltage switch.

The galvanic isolation of the inverter and the basic AC power supply from DC voltage is ensured by a 50 Hz transformer (from the inverter's side) and a high-frequency transformer (at the side of the power supply unit, if it is used).

Fig. 67 presents a standard parallel operation solution for single-phase or three-phase inverters in a free design in an industrial cabinet.

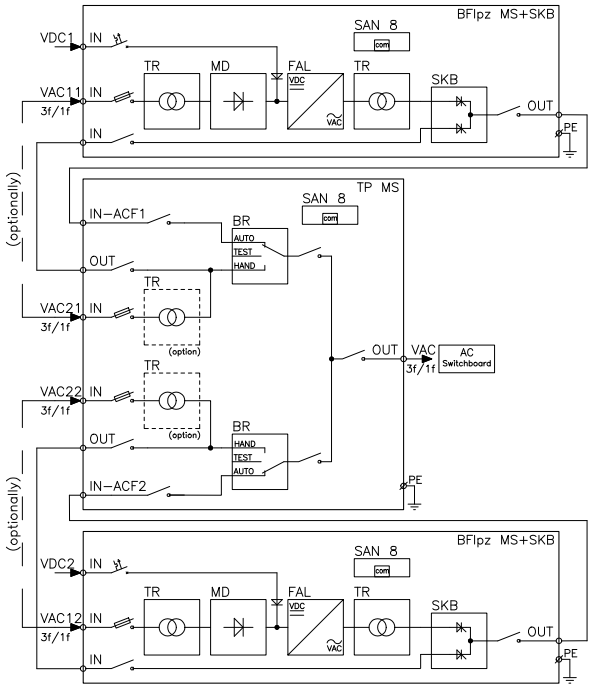
The BFIpz+SKB inverter cabinet is supplied by the basic AC network voltage, DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage). The BFIp+SKB inverter module is supplied from the DC voltage and the reserve AC network voltage. By standard, the inverter cabinet is equipped with the SAN 8 inverter operating parameters control system.

Fig. 67 a, b) presents an inverter with a power supply unit consisting of a 12-impulse transformer and a 12-impulse diode rectifier. Application of the transformer ensures galvanic isolation of DC supply voltage from the AC network, and adapts the AC supply to the needs of the inverter, which depend on the value of the DC power supply. The 12-impulse transformer may also be used to improve the THD value of the current drawn from the mains. Application of a diode rectifier significantly increases reliability of the power supply and desensitises the inverter to any disturbances in the voltage or the frequency of the mains. Apart from the diode, there are no automatics or power electronics elements in the DC power supply circuit, which guarantees certain and continuous switch of the inverter to battery operation in the case of drop or break of the mains.

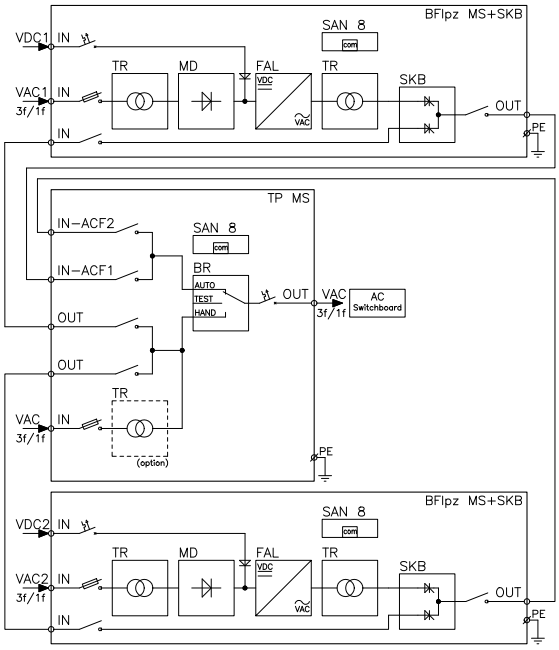
Fig. 68 presents a parallel operation solution of the inverters using an additional TP cabinet, which allows connecting inverters into the parallel operation mode. Such a solution allows easy servicing of the inverters (it is possible to completely disconnect the inverter from the TP cabinet), and facilitates the connection process (the instruments in the TP cabinet create a synoptic board that presents the design of connections between the elements of the system in a graphical manner). Usually, the TP cabinet also contains a maintenance (or an automatic and maintenance) bypass, and, optionally, a transformer in the bypass's circuit.

The inverter converts direct current into alternating current adapted via the transformer to the value accordant with the order (by standard, 230 V or 3×400 V AC).

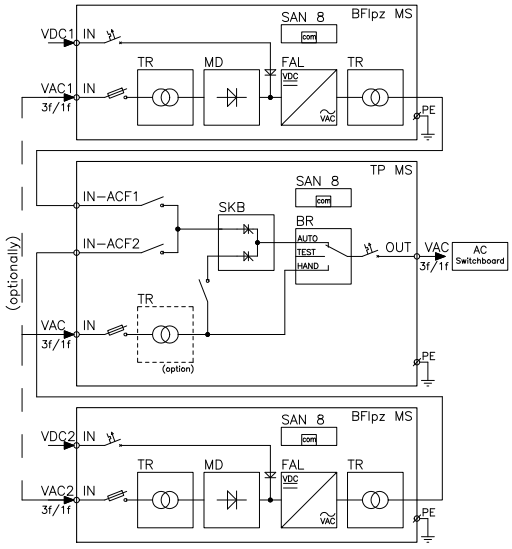
The industrial cabinet is cooled by a forced air circulation via redundant roof fans. Moreover, each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.



a)



b)



c)

Fig. 68. Block diagram of the BFIpz type inverter cabinets in a free design for parallel operation with the SKB type bypass and the TP type distribution board. Possible configurations:

a) a parallel system of two BFIpz inverters with own SKB and maintenance bypasses – two AC reserve power supplies in the TP cabinet;

b) a parallel system of two BFIpz inverters with own SKB bypasses and a single common maintenance bypass – a single common AC reserve power supply in the TP cabinet;

c) a parallel system of two BFIpz inverters with a common SKB and maintenance bypass in the TP cabinet – a single common reserve AC power supply in the TP cabinet.

The TP type switchboard is a cabinet used to safely connect inverter cabinets and manoeuvre the instruments and links of the entire system.

It may contain an automatic and maintenance bypass, as well as additional option, such as a guaranteed voltage distribution boards and measuring panels. The series type of the TP cabinets is presented in the further part of the chapter.

ADDITIONAL OPTIONS

- Active power supply (sinusoidal current draw);
- Active filter in the AC power supply (improves THDi);
- Automatic bypass;
- Maintenance bypass;
- ATSE (duplex AC power supply);
- Isolating transformer in the bypass circuit;
- Cable entry from the top;
- Special designs – upon agreement;
- Built-in output circuits distribution board – upon agreement;
- High IP.

SERIES TYPE: 1-PHASE INVERTER CABINETS 1 ÷ 20kVA FOR PARALLEL OPERATION AS PER FIG. 63 – FIG. 65

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIpz 1S 24/230 MS+SKB 1***	
7.5 / 10	60	-	BFIp 7.5S 60 / 230 MS+SKB 7.5***	
		3×400 or 230	BFIpz 7.5S 60 / 230 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20	110 / 220	-	BFIp 1S 110 / 230 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIpz 1S 110 / 230 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIpz 12.5S 110 / 230 MS+SKB 12.5***	

* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm;

*** – a cabinet without the SKB bypass is available as an option;

SERIES TYPE: 1-PHASE AND 3-PHASE INVERTER CABINETS 7.5 ÷ 240kVA FOR PARALLEL OPERATION AS PER FIG. 66

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
7.5 ÷ 20	110	3×400	BFIz 7.5T 110 / 400 MS+SKB 7.5***	600×800×2,000
30 ÷ 45			BFIz 30T 110 / 400 MS+SKB 30***	1,200×800×2,000
50 ÷ 65			BFI 50T 110 / 400 MS+SKB 50***	2,000×800×2,000
70 ÷ 90			BFIz 70T 110 / 400 MS+SKB 70***	3,000×800×2,000
95 ÷ 120			BFI 95T 110 / 400 MS+SKB 95***	3,600×800×2,000
10 ÷ 20	220		BFIz 10T 220 / 400 MS+SKB 10***	600×800×2,000
25 ÷ 45			BFIz 25T 220 / 400 MS+SKB 25***	800×800×2,000
50 ÷ 90			BFIz 50T 220 / 400 MS+SKB 50***	1,400×800×2,000
100 ÷ 135			BFIz 100T 220 / 400 MS+SKB 100***	2,000×800×2,000
150 ÷ 180			BFIz 150T 220 / 400 MS+SKB 150***	3,000×800×2,000
195 ÷ 240			BFI 195T 220 / 400 MS+SKB 195***	3,600×800×2,000

* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm;

*** – a cabinet without the SKB bypass is available as an option;

SERIES TYPE: 1-PHASE AND 3-PHASE INVERTER CABINETS 1 ÷ 400kVA FOR PARALLEL OPERATION AS PER FIG. 67 AND 68

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1T 24/400 MS+SKB 1***	600×800×2,000
		3×400 or 230	BFIpz 1T 24/400 MS+SKB 1***	
7.5 / 10	60	-	BFIp 7.5T 60 / 400 MS+SKB 7.5***	
		3×400 or 230	BFIpz 7.5T 60 / 400 MS+SKB 7.5***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10 / 12.5 / 15 / 20 / 25 / 30 / 35 / 40	110 / 220	-	BFIp 1T 110 / 400 MS+SKB 1***	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10		3×400 or 230	BFIpz 1T 110 / 400 MS+SKB 1***	
12.5 / 15 / 20		3×400	BFIpz 12.5T 110 / 400 MS+SKB 12.5***	
25 / 30 / 35 / 40			BFIpz 25T 110 / 400 MS+SKB 25***	800×800×2,000
50 / 60 / 75	110	-	BFIp 50T 110 / 400 MS+SKB 50***	1,200×800×2,000
		3×400	BFIpz 50T 110 / 400 MS+SKB 50***	1,400×800×2,000
50 / 60	220	-	BFIp 50T 220 / 400 MS+SKB 50***	600×800×2,000
50		3×400	BFIpz 50T 220 / 400 MS+SKB 50***	800×800×2,000
75		-	BFIp 75T 220 / 400 MS+SKB 75***	
60 / 75		3×400	BFIpz 60T 220 / 400 MS+SKB 60***	1,400×800×2,000
100 / 120 / 140 / 150		-	BFIp 100T 220 / 400 MS+SKB 100***	1,200×800×2,000
100 / 120		3×400	BFIpz 100T 220 / 400 MS+SKB 100***	1,600×800×2,000
160		-	BFIp 160T 220 / 400 MS+SKB 160***	1,400×800×2,000
140 / 150 / 160		3×400	BFIpz 140T 220 / 400 MS+SKB 140***	2,000×800×2,000
180 / 200		-	BFIp 180T 220 / 400 MS+SKB 180***	1,800×800×2,000
180 / 200 / 220 / 250		3×400	BFIpz 180T 220 / 400 MS+SKB 180***	3,000×800×2,000
220 / 250		-	BFIp 220T 220 / 400 MS+SKB 220***	2,000×800×2,000
300 / 350		-	BFIp 300T 220 / 400 MS+SKB 300***	3,000×800×2,000
300		3×400	BFIpz 300T 220 / 400 MS+SKB 300***	3,600×800×2,000
400		-	BFIp 400T 220 / 400 MS+SKB 400***	3,200×800×2,000

* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm; the dimension of the enclosure may be increased in the case of use of a transformer in the bypass circuit;

*** – a cabinet without the SKB bypass is available as an option;

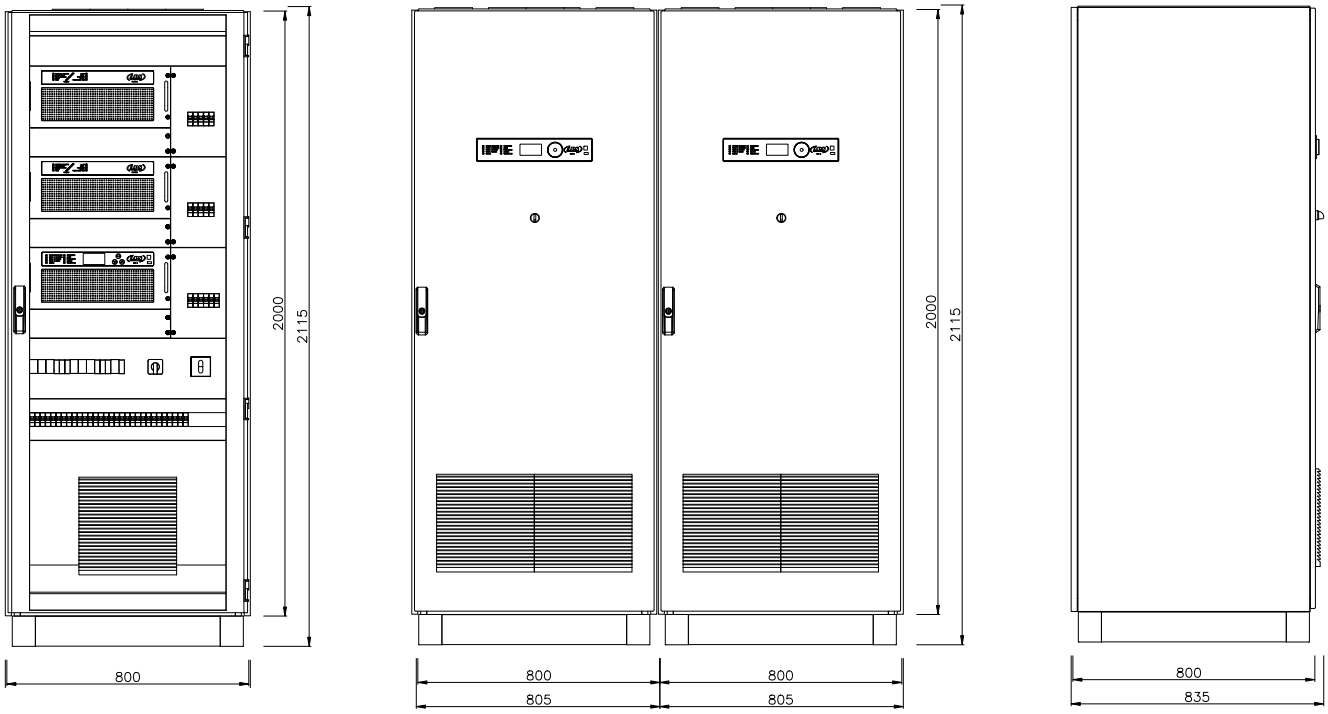
SERIES TYPE: 1-PHASE AND 3-PHASE TP CABINETS FOR COOPERATION WITH INVERTER CABINETS (INDUSTRIAL CABINETS – AS PER FIG. 68)

Rated output voltage 230 or 3×400 V AC*

Power, [kVA]	Optionally, a transformer in the bypass circuit	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 ÷ 25	Yes	TP 1	600×800×2,000
30 ÷ 50		TP 30	800×800×2,000
60 ÷ 100		TP 60	1,200×800×2,000
110 ÷ 250		TP 110	1,600×800×2,000
260 ÷ 400		TP 260	2,200×800×2,000

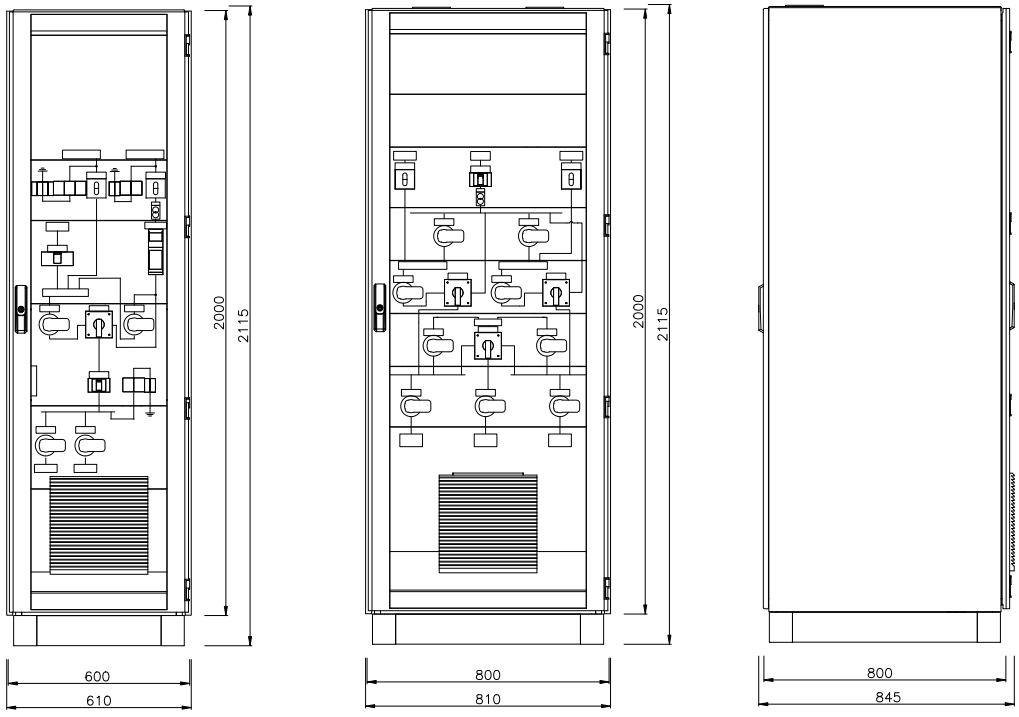
* – possible options: 220 / 230 / 240 / 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm; the dimension of the enclosure may be increased in the case of use of a transformer in the bypass circuit;



a) b) c)

Fig. 69. Views with dimensions of the BFIpz / BFIp type inverter cabinet:
a) 800×800×2,000 cabinet (modular design) – front view; b) (2×800)×800×2,000 cabinet (free design) – front view;
c) a cabinet of depth of 800 mm – left-side view.



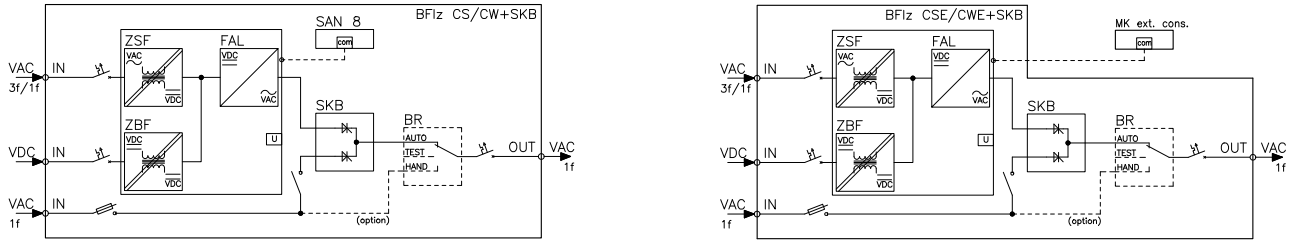
a) b) c)

Fig. 70. Views with dimensions of the TP type switch cabinet:
a) 600×800×2,000 cabinet – front view; b) 800×800×2,000 cabinet – front view; c) cabinet of depth of 800 mm – left-side view.

COMPACKT DESIGN INVERTERS

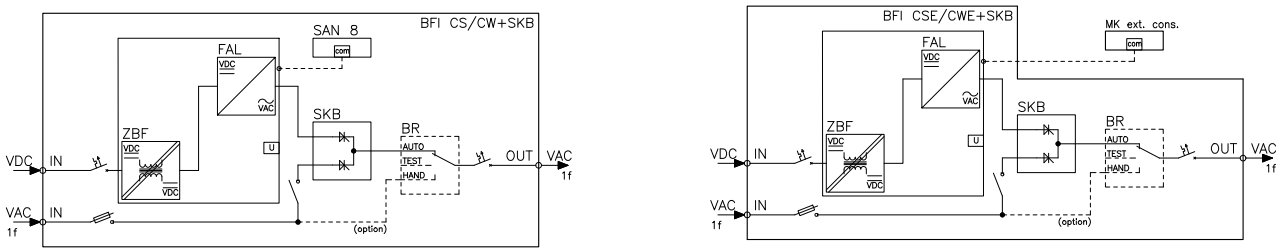
THE INVERTER COMPACT INTENDED FOR AUTONOMOUS OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE

This chapter presents single-phase type BFIz / BFI inverters in a compact form. They are intended for installation on a substrate (CS standing compact) or on a wall (CW wall-mounted compact). The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.



a) b)

Fig. 71. Block diagram of the BFIz type inverter compact with a power supply unit and the SKB type bypass: a) with a built-in console; b) with an external MK console.



a) b)

Fig. 72. Block diagram of the BFI type inverter compact with the SKB bypass: a) with a built-in console; b) with an external MK console.

The BFIz+SKB inverter compact is supplied by the basic AC network voltage, the DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFI+SKB inverter compact is supplied from the DC voltage and a reserve AC network voltage. By standard, the inverter compact is equipped with a SAN 8 inverter operating parameters control system. Compacts with a built-in SAN 8 console are presented in Fig. 71 a) and Fig. 72 a), compacts with an external MK console are presented in Fig. 71 b) and Fig. 72 b).

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of value according to the order. The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIz / BFI compacts may be equipped with the SKB automatic bypass system and a maintenance bypass uninterrupted switch.

Each compact is cooled with fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

ADDITIONAL OPTIONS

- Active filter (sinusoidal power draw);
- Automatic bypass;
- Maintenance bypass;
- Isolating input transformer;
- Special designs;
- Protection of circuits at the input and the output (standard);
- Built-in output circuits distribution board;
- 1-phase power supply.

SERIES TYPE: 1-PHASE INVERTER COMPACTS 1 ÷ 10kVA FOR AUTONOMOUS OPERATION

Rated output voltage 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions**
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFI 1S 24/230 CS***+SKB 1****	CW1
		3×400 or 230	BFIz 1S 24/230 CS***+SKB 1****	
7.5	60	-	BFI 7.5S 60 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5	110 / 220	-	BFI 1S 110 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIz 1S 110 / 230 CS***+SKB 1****	
3 / 3.5 / 5	110	-	BFI 3S 110 / 230 CS***+SKB 3****	CW1
		3×400	BFIz 3S 110 / 230 CS***+SKB 3****	
7.5 / 10		-	BFI 7.5S 110 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFI 1S 220 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIz 1S 220 / 230 CS***+SKB 1****	
7.5 / 10		-	BFI 7.5S 220 / 230 CS***+SKB 7.5****	CW1
		3×400	BFIz 7.5S 220 / 230 CS***+SKB 7.5****	

* – possible options: 220 / 230 /240 V AC;

** – CS6: 500×(2×700)×250; CW1: 800×1,000×300; CW6: 500×700×250. (W×H×D);

*** – possible options: CS / CSE / CW / CWE;

*** – a compact without the SKB bypass is available as an option.

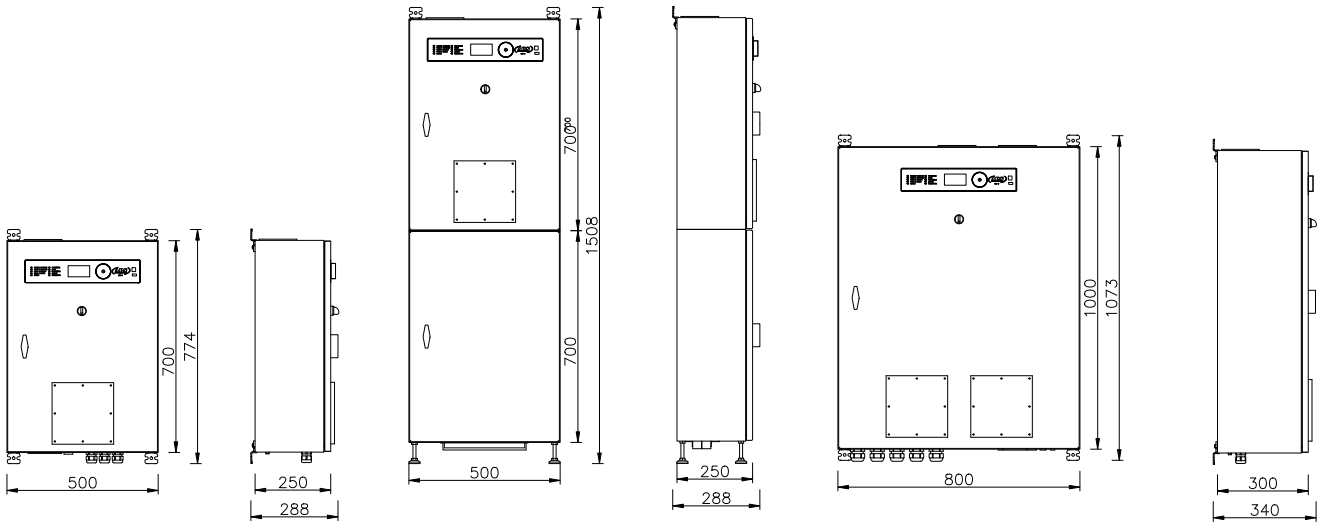


Fig. 73. Views with dimensions of the BFIz / BFI type inverter compact:
a) CW6 compact – front view; b) CW6 compact – left-side view; c) CS6 compact – front view;
d) CS6 compact – left-side view; e) CW1 compact – front view; f) CW1 compact – left-side view.

THE INVERTER COMPACT INTENDED FOR PARALLEL OPERATION WITH GALVANIC ISOLATION AT THE AC AND DC SUPPLY VOLTAGE SIDE

This chapter presents single-phase type BFIpz / BFIp inverters in a compact form. They are intended for installation on a substrate (CS standing compact) or on a wall (CW wall-mounted compact). The main task of an inverter is to continuously supply loads with the AC guaranteed voltage.

The BFIpz / BFIp inverter compact is intended for parallel operation with an inverter of the same type. This allows increasing the output power of the system or obtaining redundancy for the components of "1+1" system.

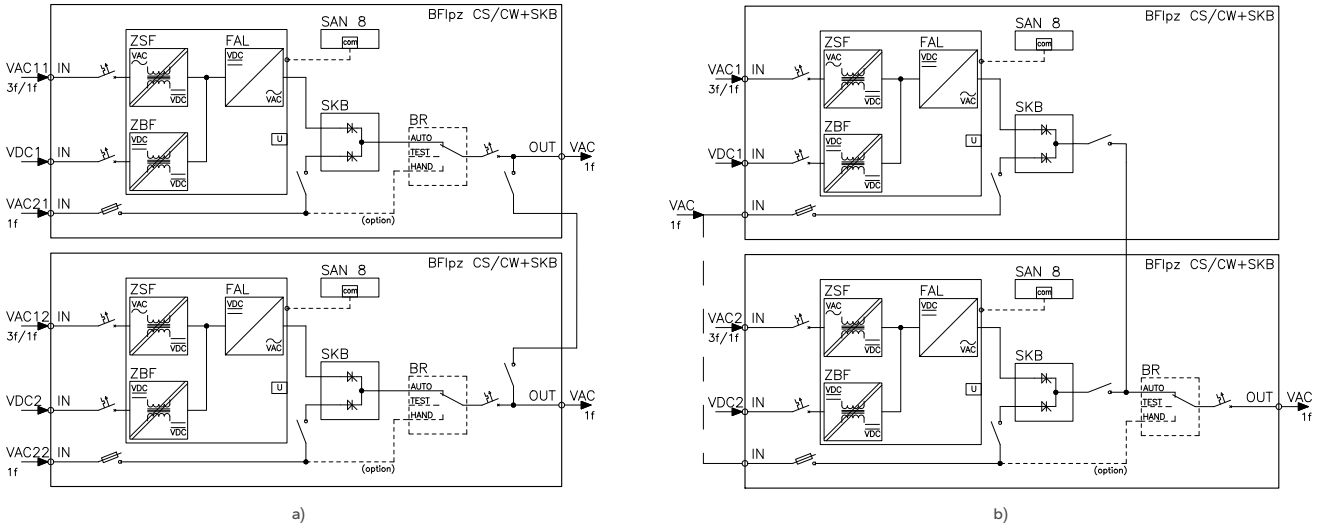


Fig. 74. Block diagram of the BFIpz inverter compact for parallel operation with a power supply unit and the SKB type bypass. Possible configurations: a) two autonomous maintenance bypass switches, a built-in console; b) a common maintenance bypass switch, a built-in console.

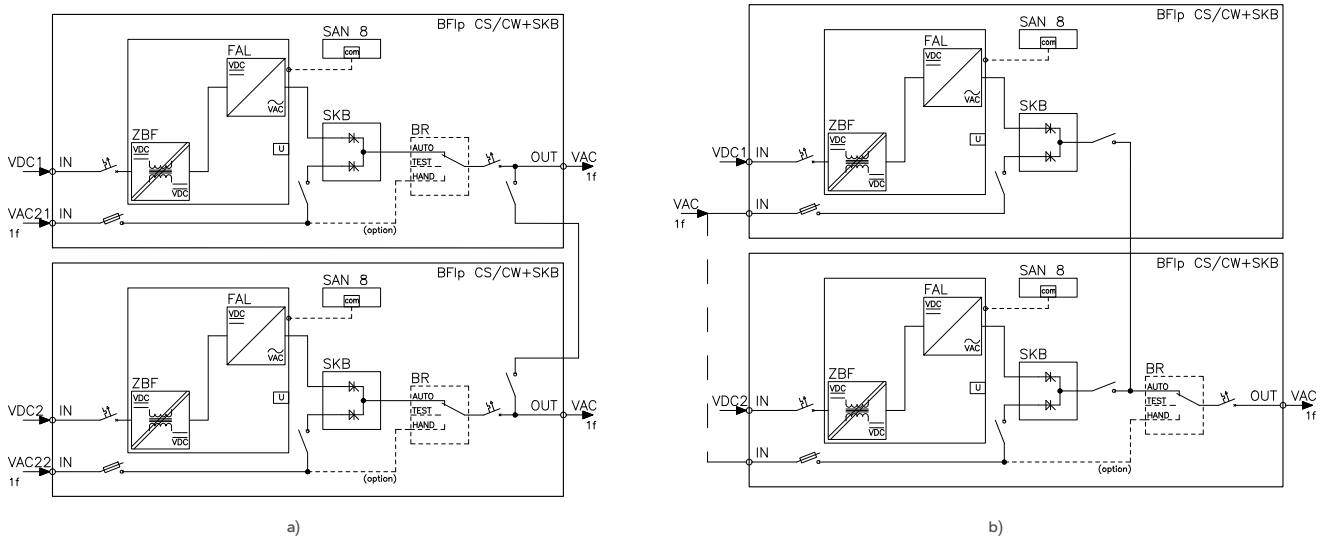


Fig. 75. Block diagram of the BFIp type inverter compact for parallel operation with the SKB type bypass. Possible configurations: a) two autonomous maintenance bypass switches, a built-in console; b) a common maintenance bypass switch, a built-in console.

The BFIpz inverter compact is supplied by the basic AC network voltage, the DC voltage, as well as the AC reserve network voltage (the automatic bypass supply voltage – this is a standard solution used to increase the reliability of the system). On the other hand, the BFIp inverter compact is supplied from the DC voltage and a reserve AC network voltage. By standard, the compact is equipped with the SAN 8 inverter operating parameters control system.

The inverter's power supply (mains converter) converts the basic alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the inverter's circuits at the same time.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The inverter converts direct current into alternating current of value according to the order. The galvanic isolation of the inverter's input voltage from AC and DC supply voltages of the inverter is ensured by high-frequency isolating transformers located in the mains converter or the battery converter of the inverter.

The BFIpz / BFIp compacts may be equipped with the SKB automatic bypass system and a maintenance bypass uninterrupted switch.

Inverters and automatic bypasses in this configuration operate as MASTER / SLAVE, and do not require additional synchronising systems.

Each compact is cooled with fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

ADDITIONAL OPTIONS

- Active filter (sinusoidal power draw);
- Automatic bypass;
- Maintenance bypass;
- Isolating input transformer;
- Special designs;
- Protection of circuits at the input and the output (standard);
- Built-in output circuits distribution board;
- 1-phase power supply.

SERIES TYPE: 1-PHASE INVERTER COMPACTS 1 ÷ 10kVA FOR PARALLEL OPERATION

Rated output voltage: 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Enclosure dimensions**
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	-	BFIp 1S 24/230 CS***+SKB 1****	CW1
		3×400 or 230	BFIpz 1S 24/230 CS***+SKB 1****	
7.5	60	-	BFIp 7.5S 60 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5	110 / 220	-	BFIp 1S 110 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIpz 1S 110 / 230 CS***+SKB 1****	
3 / 3.5 / 5	110	-	BFIp 3S 110 / 230 CS***+SKB 3****	CW1
		3×400	BFIpz 3S 110 / 230 CS***+SKB 3****	
7.5 / 10		-	BFIp 7.5S 110 / 230 CS***+SKB 7.5****	
1 / 2 / 2.5 / 3 / 3.5 / 5	220	-	BFIp 1S 220 / 230 CS***+SKB 1****	CS6 / CW6
		3×400 or 230	BFIpz 1S 220 / 230 CS***+SKB 1****	
7.5 / 10		-	BFIp 7.5S 220 / 230 CS***+SKB 7.5****	CW1
		3×400	BFIpz 7.5S 220 / 230 CS***+SKB 7.5****	

* – possible options: 220 / 230 /240 V AC;

** – CS6: 500×(2×700)×250; CW1: 800×1,000×300; CW6: 500×700×250. (W×H×D);

*** – possible options: CS / CSE / CW / CWE;

*** – a compact without the SKB bypass is available as an option.

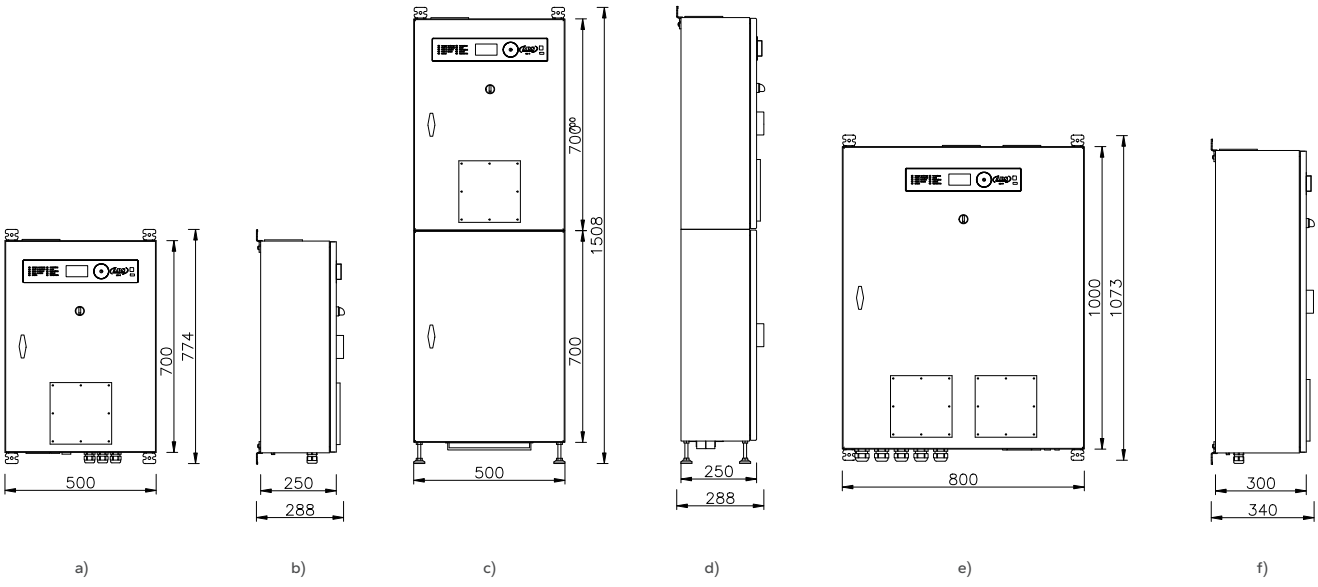


Fig. 76. Views with dimensions of the BFIpz / BFIp type inverter compact:
a) CW6 compact – front view; b) CW6 compact – left-side view; c) CS6 compact – front view;
d) CS6 compact – left-side view; e) CW1 compact – front view; f) CW1 compact – left-side view.

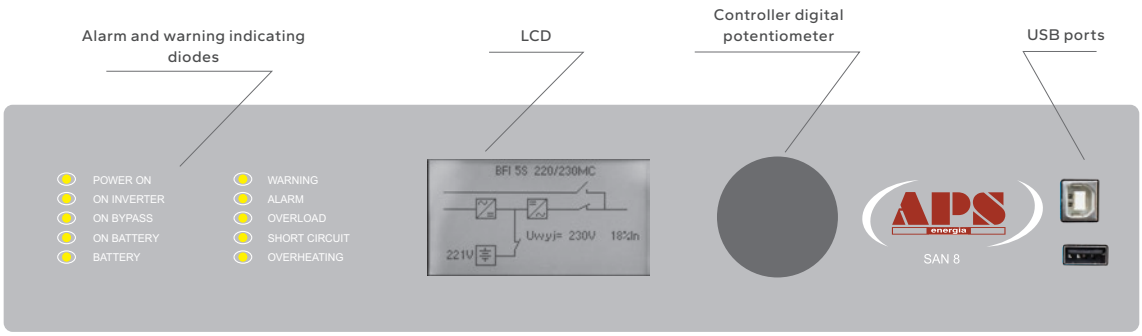
SAN 8 EXTERNAL COMMUNICATION – ALTERNATING CURRENT SYSTEMS

The inverters and converters are equipped with an extensive communication system with the user and master systems – HMI (Human Machine Interface).

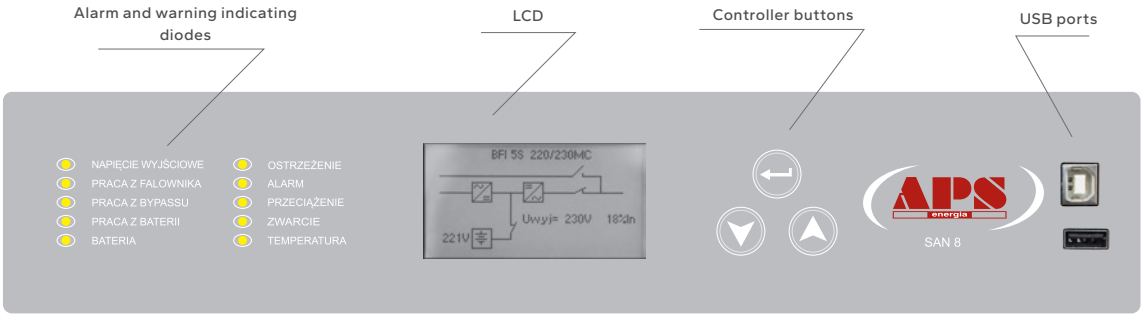
THE COMMUNICATION SYSTEM CONSISTS OF:

1. A local user panel consists of indicator diodes, an LCD screen for displaying messages and reading parameters, as well as a digital potentiometer and cursors used to navigate the console menu.
2. A set of potential-free relay contacts for I/O binary signals.
3. External communication links. Data transmission is possible via RS485, USB (archive buffers readout), and Ethernet ports.

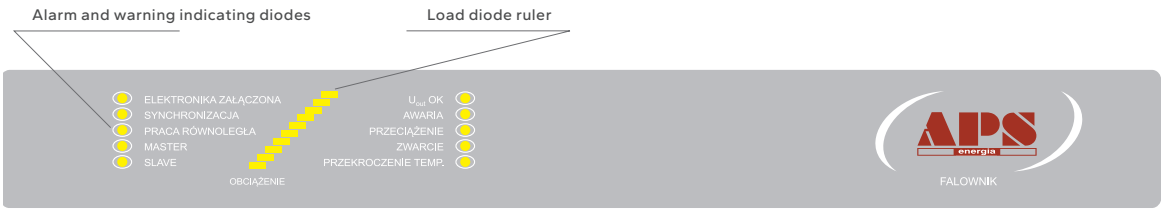
LOCAL USER PANEL



View of the console with a digital potentiometer



View of a console with navigation cursors



View of the console without a display, for modules in multi-module systems and with a separate controller

SAN 8 MEASURED PARAMETERS:

Output current, phase L1	Power factor
Output current, phase L2	Output current, phase L1 percentage
Output current, phase L3	Output current, phase L2 percentage
L1 phases output voltage	Output current, phase L3 percentage
L2 phases output voltage	Battery's voltage (UPS)
L3 phases output voltage	Battery current (UPS)
L1 phases input voltage	Battery operation autonomy time (UPS)
L2 phases input voltage	Battery's charge (UPS)
L3 phases input voltage	Charge percentage value (UPS)
Ambient temperature	Apparent power
Active power	

SIGNALLED SAN 8 ALARMS INCLUDING DESCRIPTION ON THE LCD SCREEN:

Collective alarm	Power supply failure
Warning	Battery converter failure
Internal error	Rectifier failure
Inverter short circuit	Low battery voltage
Overload	No battery charging
Inverter supplied operation	Battery discontinuity
Bypass supplied operation	maintenance bypass on
Battery supplied operation	Output voltage drop
Basic power supply failure	No synchronization
Inverter failure	Ambient temperature out of tolerance
Bypass failure	Inverter temperature
Battery failure	No reserve network power supply

INTEGRATED RS485, USB, ETHERNET COMMUNICATION INTERFACES

RS485 LINK

RS485 is a wired interface used in industrial networks. The basic advantage of data transmission via RS485 bus bar is resistance to external distortions (e.g., caused by inductive devices, such as electric motors). The RS485 standard allows to connect many transmitters and loads (up to 32). The range of this standard is approx. 1,200 m.

The RS485 link of the device features APS6000, Modbus RTU, IEC 60870-5-103 transmission protocols. They allow reading a complete set of data from the device.

By use of an external converter, it is possible to transmit data in the Profibus DP protocol.

USB LINK

In the APS Energia SA devices, the USB link is used to copy archive logs saved during operation.

The USB port (A) is used to connect mass memory (USB flash drive).

The USB port (B) operating in the mass memory mode; after connecting it to a PC, it is shown as an additional drive.

ETHERNET LINK

Ethernet (IEEE 802.3) is the most commonly used technology in local networks (LAN). This interface allows connecting the device to a local computer network in the facility, and thus easily read data even from several stations at the same time.

The Ethernet interface may be designed in to ways:

1. A link incorporated into a controller with an implemented Modbus TCP, SNMP protocol;
2. An additional converter may provide transmission in one of the following protocols:
   - IEC 61850 (APS SAN KP1 converter)
   - SNMP (AGENT- APS2 converter)
   - Modbus TCP (external converter)

Storage of events and states of the operation of the device and an SD memory card.

An internal memory card stores data saved in the events buffer and the archive buffer. Lack of a card makes saving logs impossible and is indicated on the display by "SD" symbol.

BFI AND BFIz INVERTERS: INPUT BINARY SIGNALS – CONTROL:

Fire-fighting switch (EPO)
START/STOP inverter switch
Reserve
ATSE

The USB type port (A)

The USB type port (B) sends archive data directly to a PC

BFI AND BFIz INVERTERS: OUTPUT BINARY SIGNALS:

8 STANDARD SIGNALS:	8 ADDITIONAL SIGNALS (SELECTABLE):
1. Alarm	1. Basic power supply failure
2. Warning	2. Inverter failure
3. Inverter supplied operation	3. No bypass power supply
4. Bypass supplied operation	4. Battery failure
5. Overload	5. Power supply failure
6. Battery supplied operation	6. Battery converter failure
7. Low battery voltage	7. No battery charging
8. maintenance bypass on.	8. Rectifier failure
	9. Battery discontinuity
	10. Drain deactivation
	11. Output voltage drop
	12. No sync
	13. ATSE power supply
	14. Ambient temperature out of tolerance
	15. Inverter overheating
	16. tripping of the fire-fighting switch

STATIC SWITCHES

The Static Switch (SKB) is an electronic reserve tripping system. It controls power lines and, in the case of break of supply voltage (or exceeding of a specific range by the parameters), switches loads to supply from another power supply field of parameters meeting the electric requirements.

The SKB system ensures uninterrupted (5 ms switching time), binary power supply for devices and entire industrial facilities, telecommunication and computer switches, public utility facilities, and other, where continuity of operation of devices must be ensured.

THE CHARACTERISTICS OF THE SKB, MWB TYPE STATIC SWITCHES:

- a microprocessor control system;
- an advanced power lines voltage parameters analysis algorithm;
- quick switching within the range (0 to 10 ms depending on the synchronisation of voltages);
- a possibility to select the basic or reserve line;
- a possibility to block automatic return to the basic line;
- a possibility to manually switch power supply between the lines;
- selection of the basic line return mode in the case of cessation of the cause of the switch (or an option to remain on the reserve line);
- operation in the wide load cos Φ range;
- high resistance to overload and difficult operating conditions;
- a built-in synoptic panel, indication of the operating status and power lines;
- high efficiency;
- advanced communication between the user and the device: keyboard, control console with LCD, indicating LEDs, application of all binary signals to potential-free relay contacts;
- data archiving and events buffer on SD card;
- RS485, USB and Ethernet integrated communication interfaces;
- wide selection of data transmission protocols: Modbus RTU, IEC 60870-5-103, IEC 61850, SNMP; APS6000; other
- SAN 8 microprocessor monitoring of the entire system.

View of the SKB compact

View of the SKB cabinet

METHOD OF DESIGNATION OF THE SKB TYPE STATIC SWITCHES

SKB ☐☐ ☐ ☐

Device type: SKB - Static Switch
Power, [kVA]
Configuration of the SKB bypass system*
AC rated voltage, [V] By standard: 220; 230; 240; 380; 400; 415 Other solutions depend on the order
Type of enclosure: M - 19" module without controller MC - 19" module with mounted controller MCE - 19" module with an external console MS - an industrial cabinet CS - standing compact CSE - standing compact with an external console CW - wall-mounted compact CWE - wall-mounted compact with an external console

METHOD OF DESIGNATION OF THE MWB TYPE STATIC SWITCHES

MWB ☐☐ ☐ ☐

Device type: MWB - bypass module that enables parallel operation of inverters
Power, [kVA]
Configuration of the SKB bypass system*
AC rated voltage, [V] By standard: 220; 230; 240; 380; 400; 415 Other solutions depend on the order
Type of enclosure: M - 19" module without controller MC - 19" module with mounted controller MCE - 19" module with an external console

Note: The MWB type static switches is a module that enables parallel operation of the inverters.

* - it means the configuration of thyristor switches in the SKB system:

S - Single-phase circuit. Thyristors switch only the L phase voltages. The neutral conductors (N) are permanently connected;

S2 - Single-phase or two-phase circuit. Thyristors switch L and N voltages in a single-phase circuit or L1 and L2 voltages in a two-phase circuit;

T - Three-phase circuit. Thyristors switch only the L1, L2, L3 phase voltages. The neutral conductors (N) are permanently connected;

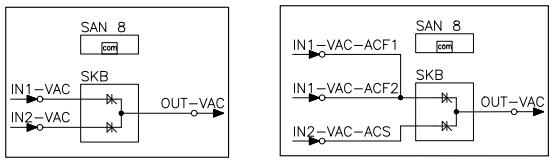
T4 - Three-phase circuit. The thyristors switch the L1, L2, L3, N voltages.

THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE
AC* INPUT, NO. 1, NO. 2	
Input voltage:	1×220 / 1×230 / 1×240 / 2×120 / 2×230 / 2×480 / 3×380 / 3×400 / 3×415 V
Input voltage tolerance	+10 % to -15 %
Frequency of input voltage	50 Hz
Input voltage frequency tolerance	±10 %
AC OUTPUT	
Output voltage:	1×220 / 1×230 / 1×240 / 2×120 / 2×230 / 2×480 / 3×380 / 3×400 / 3×415 V
Output voltage tolerance	+10 % to -15 %
Output voltage frequency	50 Hz
Output voltage frequency tolerance	±10 %
Overload indication	In
The time of switching to reserve power supply	5 ms
Overload capacity	1.1×In long-term <1.25×In within 10 min <1.5×In within 60s >1.5×In within 1s
Short-circuit strength	10×In within 20 ms
Cos Φ range	from -1.0 to 1.0
Inverter efficiency	>99%
Available menu language versions	PL | EN | CZ | RU
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front*
Cable entry	from the bottom / from the top**
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;

** – only for installation in the industrial cabinet (MS enclosure type).



a) b)

Fig. 77. General block diagram of the static switch system:
a) the SKB type; b) the MWB type.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BR – maintenance bypass	com – communication
I – current measurement	OUT – output
IN – power supply	SAN 8 – console
IN-ACF – AC supply from the inverter	SKB – automatic bypass
IN-ACS – AC supply from the mains	VAC – alternating current (AC)

The SKB type Static Switch (also known as the automatic bypass) is a quick thyristor switch that ensures switching of loads to the AC reserve line power supply in the case of break of the alternating current in the basic line. The switching time is 5 ms or 10 ms (depending on the synchronisation of those voltages – see table "STATIC SWITCH SYSTEM SWITCHING CHARACTERISTICS"). It is used to increase the reliability of the AC power supply system. The SKB system is presented in Fig. 77 a).

Fig. 77 b) presents a version of the MWB type static switch, in which one of the inputs is double, which allows connecting with two inverters operating in parallel.

STATIC SWITCH SYSTEM SWITCHING CHARACTERISTICS

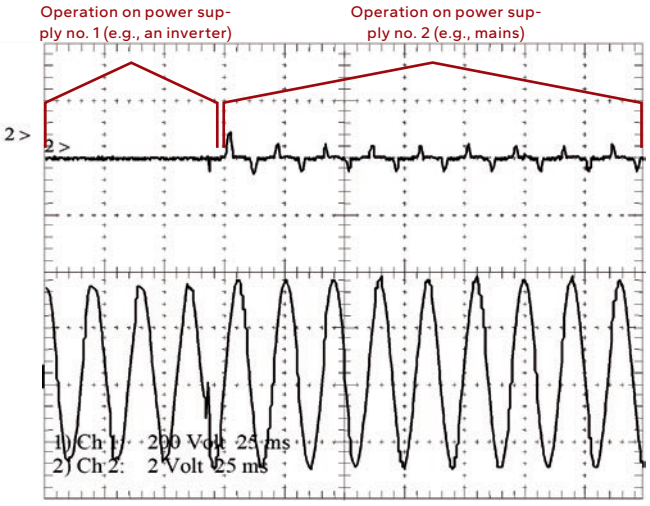


Fig. 78. Switching of the SKB system from line no. 1 (e.g., an inverter) to the voltage of the line no. 2 (e.g., mains).

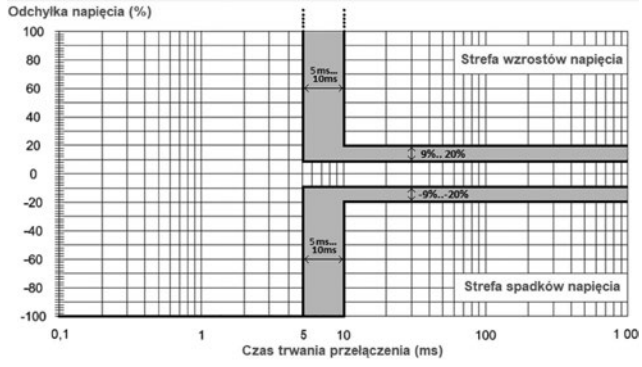
where: Ch1 – system output voltage

Ch2 – current drawn from the mains

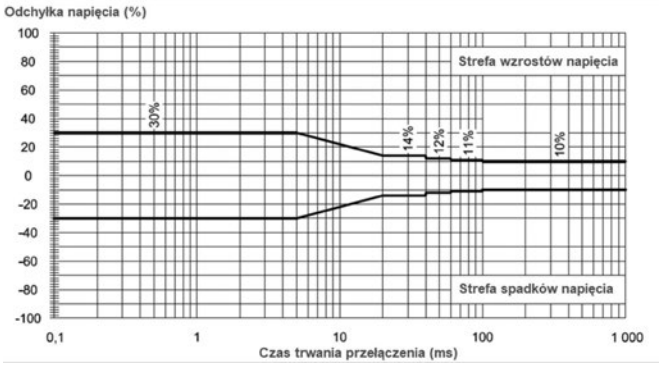
The oscillogram in Fig. 78 presents an uninterrupted (<5 ms) switching of the microprocessor bypass system (SKB) to supplying loads from the AC reserve line in the case of damage to the basic AC power line. There is a maintenance bypass switch at the output of this Static Switch system.

Switching of the SKB system is done within 5 ms only if both switched sources operate synchronously (i.e., during normal operation of the system). In other cases, switching is done with a 10 ms interruption.

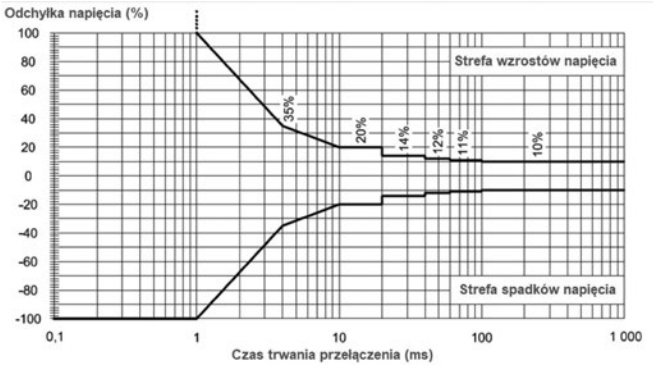
This characteristic is default for both SKB and MWB system.



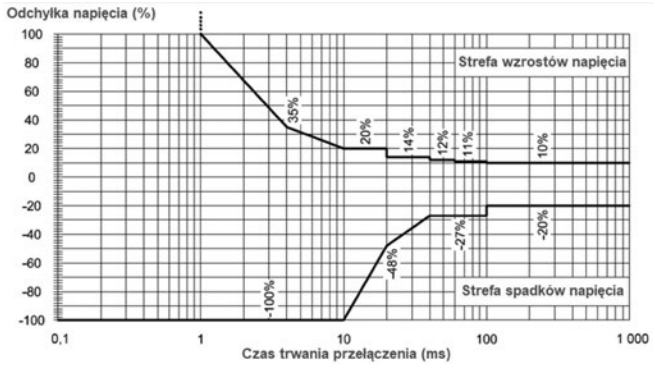
a)



b)



c)



d)

Fig. 79. Line voltage fault characteristics:
a) the APS4 type; b) as per EN62040 – 3 Class 1; c) EN62040 – 3 Class 2; d) EN62040 – 3 Class 3.

The task of the Static Switch system is to ensure continuity of power supply of the alternating current load during disturbances in the power line. The bypass is supplied from two lines. The switching time is 1ms to 10 ms depending on the moment of occurrence of the failure in the power line.

Fig. 79 presents possible characteristics of the power line failure, i.e., allowed values of a momentary failure of voltage in the device's input lines. Depending on the needs, any characteristic accordant with EN62040 – 3 or an individual characteristic adapted to the needs of a given power supply system may be implemented in the device. By default, the SKB has the characteristics presented in Fig. 79 a).

This system may detect current at the zero, thus allowing switching of synchronised voltages, as well as guaranteeing maintenance of the continuity of the current of loads and lack of disturbances associated with commutation.

THE SKB STATIC SWITCHES USER INTERFACE

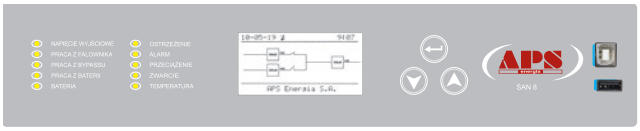
Communication between the user and the device (HMI – Human Machine Interface) takes place locally or remotely. Local communication is done via the console. Active power lines and the state of operation of the connector are presented synoptically. Indicating lamps show the active operation mode of the device.

View of the controller without a display

Remote communication takes place via potential-free contacts and the RS485 communication port with an implemented Modbus RTU transmission protocol.

Extended communication options are available.

For systems of high power (≥100kVA), the SKB type static switches are equipped with the SAN 8 control and monitoring system.



View of the controller with a console

The user may set the following parameters:

- sensitivity of the system – defining a set of power supply parameters that cause switching;
- switching time – adaptation of the system to supplied loads by defining the time of switching from one power supply field to another;
- alarm thresholds – setting the alarm threshold appropriately to the observed alarm situations, allowing ideal adjustment of the system to the electric environment in the facility.

SPECIAL DESIGNS OR EQUIPMENT OPTIONS FOR THE SKB STATIC SWITCHES

Special designs	Upon request, it is possible to adapt the devices to special requirements of a given project in relation to: 1) greater power of switches; 2) standard of the AC voltages and frequencies: a) single-phase static switches: (110 V, 115 V, 120 V, 127V, 50 / 60 Hz); b) three-phase static switches: (3×190 V, 3×200 V, 3×208V, 3×220 V, 50 / 60 Hz); 3) environmental requirements related to ambient temperature (-20 °C ÷ + +55 °C), presence of aggressive factors, etc.; 4) enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.; 5) measurements and communication: digital or analogue meters of appropriate class, signalling of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.
Bypass system	An internal system of connections and switches that allows feeding a voltage from the selected AC power network to loads, bypassing the static connector. Maintenance bypass – a mechanical switch that allows manual switching of loads to power supply from the selected power line.
"N" cable switching system	Regardless of quick switching of L phase cables for single-phase switches of L1, L2, L3 cables for three-phase switches, there is a possibility to design switches with the "N" circuit switching from various sources.
Protections of the input lines	Static switches may be equipped with protections of the input lines in accordance with the design of the entire system.
Output circuits distribution board:	In the device's enclosure, you may separate a space and incorporate an AC guaranteed voltage distribution panel equipped with protections for particular input circuits.
Cable entry from the top	It is possible to design the enclosure in a way to allow cables entering from the top (applies only to the cabinet version).
Advanced communication options	Equipping the SKB system with the SAN 8 monitoring system.
Adjustment of parameters	The users may adjust the sensitivity of the system and the switching time.

MODULAR DESIGN STATIC SWITCHES

This chapter presents the SKB and MWB single-phase and three-phase Static Switch systems in a form of a 19" module of standard height of 4U or 6U. They are adapted for mounting in industrial cabinets. The main task of the Static Switch system is ensuring uninterrupted operation of electrical devices by activating the reserve in the case of break of the supply voltage.

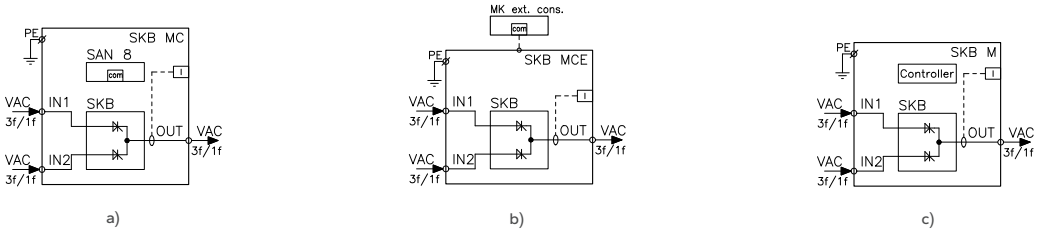


Fig. 80. Block diagram of the SKB type static switch:
a) with a built-in console; b) with an external MK console; c) with a controller.

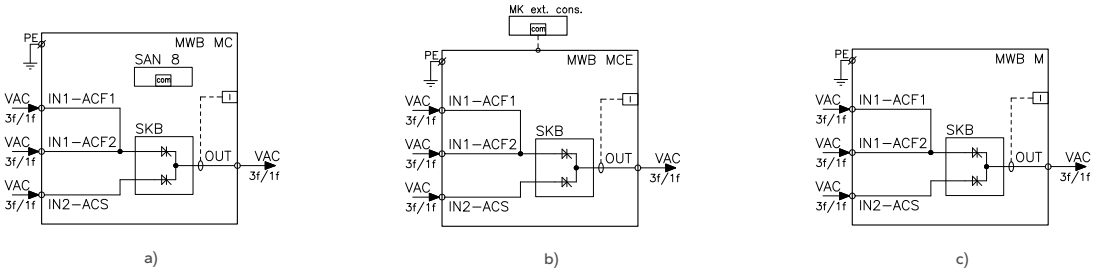


Fig. 81. Block diagram of the MWB type static switch:
a) with a built-in console; b) with an external MK console; c) without a console.

Fig. 80 presents solutions for the SKB type static switch modules (automatic bypass). The SKB module is supplied by two AC voltages. By standard, the static switch module is equipped with the SAN 8 microprocessor operating parameters control system. The SKB modules with the SAN 8 console belong to the MC modules family (Fig. 80 a), the modules with an external MK console are a part of the MCE modules family (Fig. 80 b), while the modules with a controller belong to the M modules family (Fig. 80 c). The module presented in Fig. 80 c) does not have the SAN 8 console for communication with the client.

The BFIz / BFI inverter module cooperates with the MWB module and the transformer, which, apart from providing a galvanic isolation, also adapts the inverter module's output voltage to an appropriate value. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

The BFIz / BFI inverter module cooperates with the MWB module and the transformer, which, apart from providing a galvanic isolation, also adapts the inverter module's output voltage to an appropriate value. The MWB module contains special LC filters, which are responsible for high quality of the inverter's voltage, and the Static Switch system (optionally).

The MWB type static switch module, presented in Fig. 81, has special LC filters responsible for high quality of the voltage and, optionally, may have an automatic bypass system.

This module is used when:

- connecting two inverter modules for parallel operation with a common automatic bypass in the MWB module;
- cooperating with the inverter and the 50 Hz transformer to obtain three-phase voltage at the output of the power supply system.

The MWB modules with the SAN 8 console belong to the MC modules family (Fig. 81 a), the modules with an external MK console are a part of the MCE modules family (Fig. 81 b), while the modules with a controller belong to the M modules family (Fig. 81 c).

In the case of the SKB devices, the key parameter impacting the size of the device is the rated current. For example: SKB 30S 230 M and SKB 60S 480 M will have the same size.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

SERIES TYPE: 1-PHASE AND 3-PHASE SKB TYPE STATIC SWITCHES MODULES 1 ÷ 60kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Maximum current, [A]	Rated AC* output voltage, [V]	Example type	Enclosure dimensions**
from 1 to 60	140	230	SKB 1S 230 M***	M4

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS";
** – M4 (4U): 482×142×496. (W×H×D);
*** – possible options: M / MC / MCE.

SERIES TYPE: 1-PHASE AND 3-PHASE MWB TYPE STATIC SWITCHES MODULES 1 ÷ 10kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Rated AC* output voltage, [V]	Example type	Enclosure dimensions**
from 1 to 10	230	MWB 1S 230 M***	M3

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – standard parameters";
** – M3 (6U): 482×267×496; (W×H×D);
*** – possible options: M / MC / MCE.

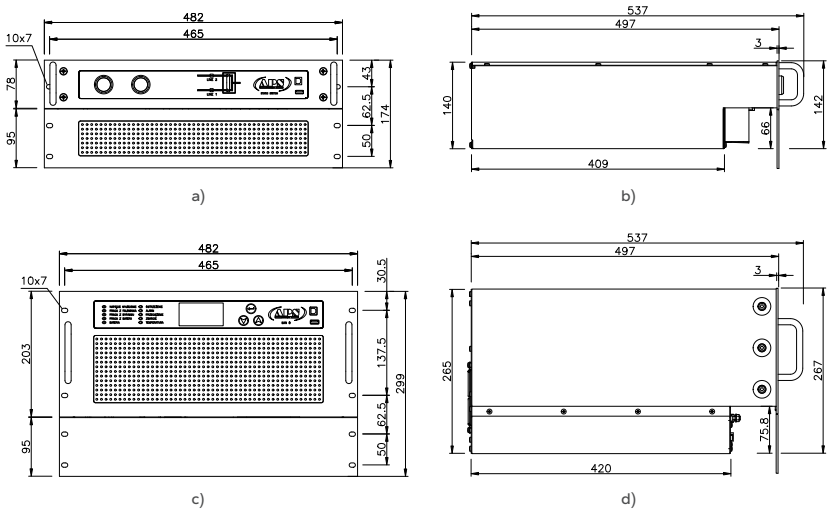


Fig. 82. Views with dimensions of the static switch module:
a) front view of the SKB M type – M4 module; b) left-side view of the M4 module; c) front view of the MWB MC type – M3 module; d) left-side view of the M3 module.

STATIC SWITCHES BUILT IN A CABINET

This chapter presents the SKB type single-phase and three-phase Static Switch system in a form of a 19" industrial cabinet for installation on a substrate. The main task of the Static Switch system is ensuring uninterrupted operation of electrical devices by activating the reserve in the case of break of the supply voltage.

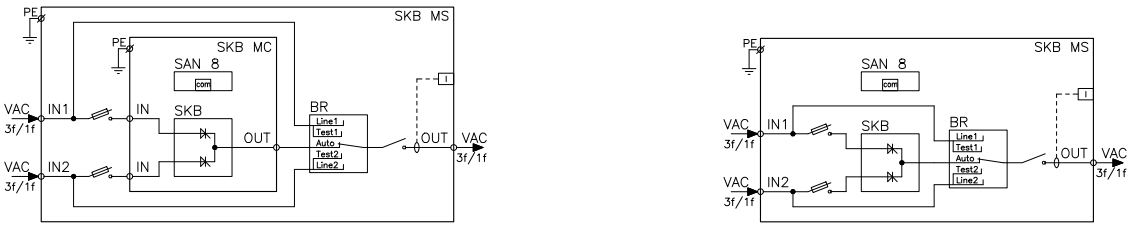


Fig. 83. Block diagram of the SKB type static switch cabinet:
a) modular design; b) free design.

Fig. 83 a) presents a standard solution of the SKB type modular single-phase or three-phase static switches incorporated into an industrial cabinet. The description of the SKB module is presented in chapter "MODULAR DESIGN STATIC SWITCHES".

Fig. 83 b) presents a standard solution for the SKB type single-phase or three-phase static switches in a free design in an industrial cabinet.

The SKB type Static Switch cabinet is supplied by two AC voltages. By standard, the SKB static switch cabinet (automatic bypass) is equipped with the maintenance bypass system and the SAN 8 operating parameters control system.

The automatic bypass system is supplied from two alternating voltage lines. These voltages are fed to the thyristor switches. Based on the decision algorithm, the control system turns on/off a specific group of thyristors. The repair bypass allows uninterrupted switching of loads to power supply from network 1 or network 2, bypassing the system's power electronics.

The industrial cabinet is cooled by a forced air circulation via redundant roof fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

ADDITIONAL OPTIONS

- Maintenance bypass;
- ATSE (duplex AC power supply);
- Isolating transformer in the bypass circuit;
- Cable entry from the top;
- Special designs – upon agreement;
- Built-in output circuits distribution board – upon agreement;
- High IP.

SERIES TYPE: 1-PHASE AND 3-PHASE STATIC SWITCHES CABINETS 1 ÷ 100kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Maximum current, [A]	Rated AC* output voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
from 10 to 100	450	230 or 3×400	SKB 10S 230 MS	600×800×2,000
from 110 to 350	550	3×400	SKB 110T 400 MS	800×800×2,000
from 400 to 500	750		SKB 400T 400 MS	1,200×800×2,000

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS";

** – add the height of the pedestal to the height of the device: by standard, 100 mm.

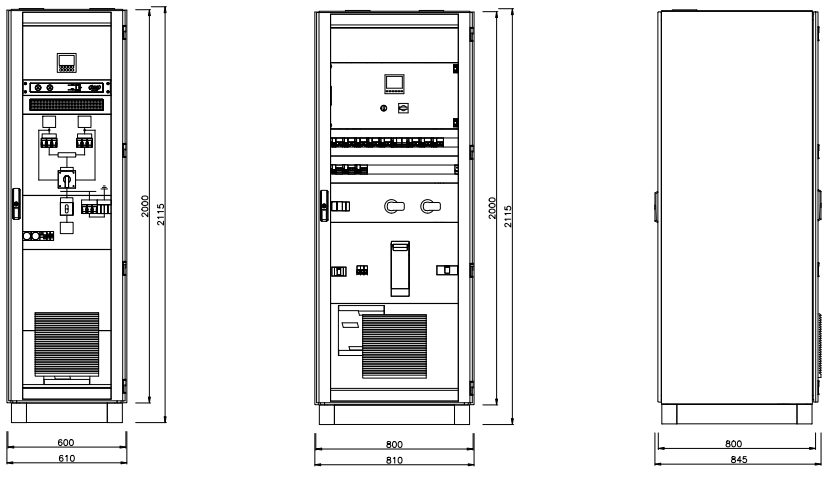
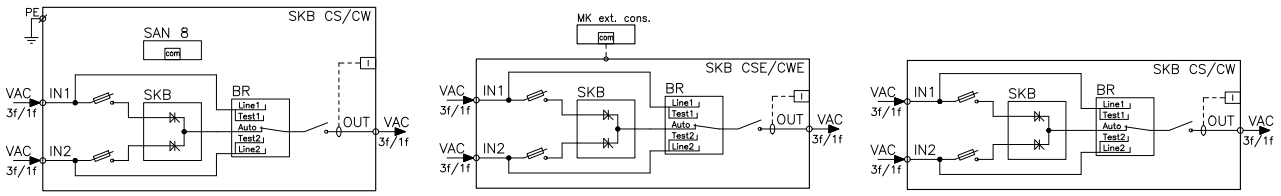


Fig. 84. Views with dimensions of the static switch cabinet:
a) 600×800×2,000 cabinet – front view; b) 800×800×2,000 cabinet – front view; c) cabinet of depth of 800 mm – left-side view.

STATIC SWITCHES IN A COMPACT ENCLOSURE

This chapter presents the SKB single-phase and three-phase static switches in a compact form. They are intended for installation on a substrate (CS standing compact) or on a wall (CW wall-mounted compact). The main task of the Static Switch system is ensuring uninterrupted operation of electrical devices by activating the reserve in the case of break of the supply voltage.



a) b) c)

Fig. 85. Block diagram of the SKB type static switch compact:
a) with a built-in console; b) with an external MK console; c) without a console.

The SKB Static Switch compact is supplied from two AC voltages. By standard, the SKB static switch compact (automatic bypass) is equipped with the maintenance bypass system and the SAN 8 operating parameters control system.

The compact with a built-in SAN 8 console is presented in Fig. 85 a), the compact with an external MK console is presented in Fig. 85 b), while the compact without a console is presented in Fig. 85 c).

The automatic bypass system is supplied from two alternating voltage lines. These voltages are fed to the thyristor switches. Based on the decision algorithm, the control system turns on/off a specific group of thyristors. The maintenance bypass allows uninterrupted switching of loads to power supply from network 1 or network 2, bypassing the system's power electronics.

Each compact is cooled with fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

ADDITIONAL OPTIONS

- Maintenance bypass;
- Special designs;
- Protection of circuits at the input and the output (standard);
- Built-in output circuits distribution board;

SERIES TYPE: 1-PHASE AND 3-PHASE STATIC SWITCHES CABINETS 1 ÷ 100kVA FOR AUTONOMOUS AND PARALLEL OPERATION

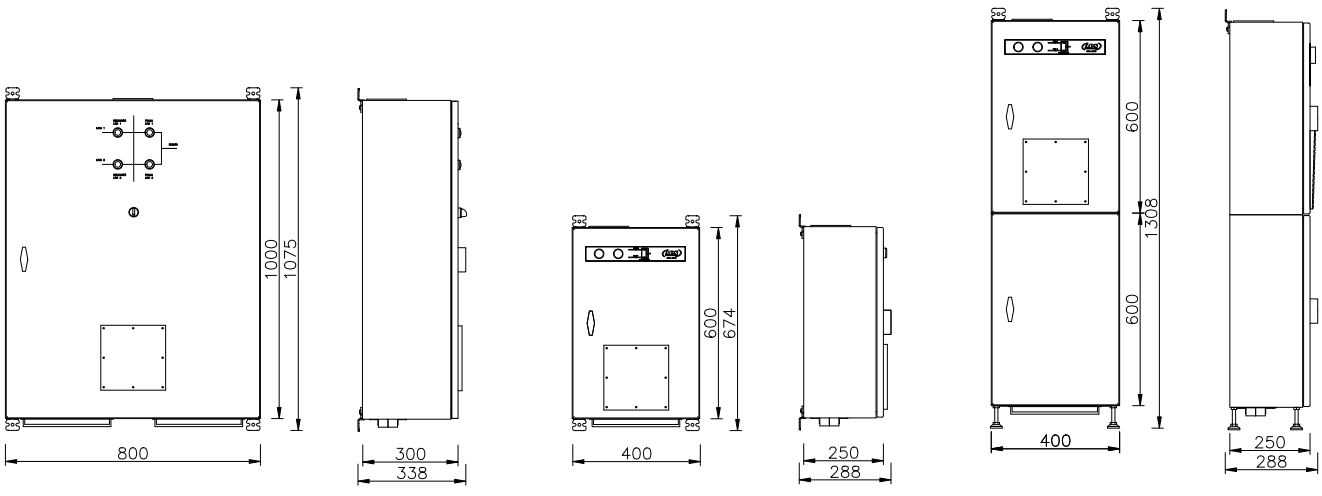
Power, [kVA]	Maximum current, [A]	Rated AC* output voltage, [V]	Example type	Enclosure dimensions**
from 1 to 60	140	230	SKB 1S 230 CS***	CS4 / CW4
70 to 100****	180	3×400	SKB 70T 400 CS***	CW1

* – possible options: see table "THE SKB / MWB TYPE STATIC SWITCHES – TECHNICAL CHARACTERISTICS – standard parameters";

** – CS4: 400×(2×600)×250; CW1: 800×1,000×300; CW4: 400×600×250. (W×H×D);

*** – possible options: CS / CSE / CW / CWE;

**** – only for 3-phase voltages.



a) b) c) d) e) f)

Fig. 86. View with dimensions of the SKB type static switch compact:
a) CW1 compact – front view; b) CW1 compact – left-side view; c) CW4 compact – front view;
d) CW4 compact – left-side view; e) CS4 compact – front view; f) CS4 compact – left-side view.

UPS SYSTEMS

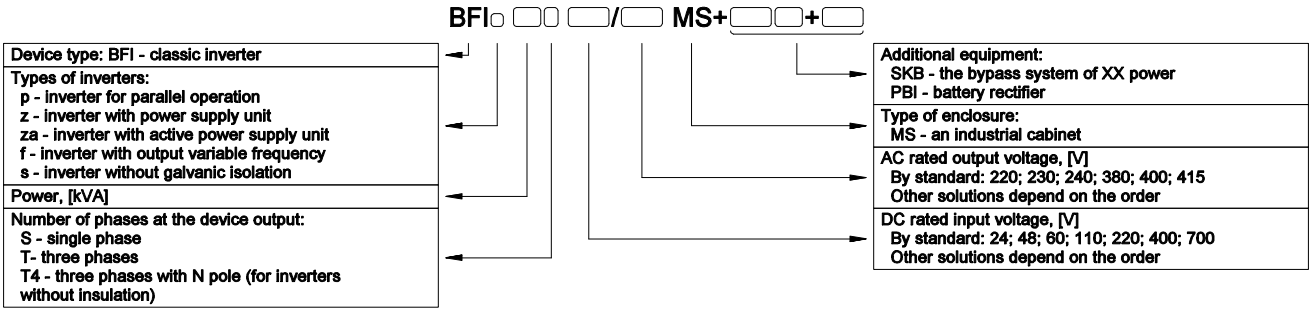
The UPS system is an Uninterruptible Power Supply. In each field of industry, there is a group of devices that play a crucial role for a specific process. These critical devices must be provided with appropriate power supply parameters to ensure correct course of the technological process, regardless of the parameters of the mains, and, in the case of break of the power supply network voltage, to ensure uninterrupted continuation of operation in a given time, i.e., until the network voltage appears again or until creating conditions for safe completion of the process. This function is provided by a guaranteed power supply system based on the BFIz type inverter. The UPS systems are complex systems tailored to the needs of the client. They consist of the BFIz inverters, the SKB static switches, the PBI rectifiers including batteries, the ATSE systems, or guaranteed voltages distribution boards.

THE CHARACTERISTICS OF THE UPS SYSTEM:

- perfectly sinusoidal output voltage shape;
- high voltage and output frequency stability;
- possible 100 % asymmetrical load (for three-phase systems);
- start-up on a battery is possible (Black start);
- a possibility to operate at any type of load (inductive or capacitive) – cos φ of the loads allowed within the entire possible range;
- autonomous controllers of particular functional systems to increase the UPS system's design reliability;
- easy operation:
  - a central inverter START/STOP switch;
  - access to the control and monitoring elements from the front;
  - access to phase connections and potential-free terminals from the front;
  - legible and user-friendly communication;
- uninterrupted automatic bypass;
- uninterrupted manual bypass;
- high short-circuit current (high selectivity of protection tripping);
- electromagnetic compatibility (EMI filters), resistance to disturbances;
- galvanic isolation of loads from the DC sources;
- an advanced charging and accumulator batteries monitoring system;
- independent battery rectifier dedicated to accumulator batteries;
- protection against excessive discharge of the supply battery;
- low ripple and low level of higher harmonics of the battery's current;
- the battery's temperature management and temperature compensation of the battery charging voltage;
- control of the battery charging current;
- over-voltage, over-current, short-circuit protection, etc.;
- advanced communication between the user and the device, a keyboard, a control console with an LCD screen and LEDs, potential-free contacts of relays, a sound signal informing about an alarm situation, archiving of data, and an event buffer. Integrated RS485, USB and Ethernet communication interfaces allow communicating using the serial transmission protocol: Modbus RTU, Modbus TCP, IEC 60870-5-103, IEC 61850, SNMP, APS6000, other.

View of the UPS system cabinet

METHOD OF DESIGNATION OF THE UPS SYSTEM:



The basic functional element in the UPS system produced in APS Energia is the BFIz type inverter in a standard design or the BFIz inverter in the special HC design.

The HC version BFIz inverters feature higher selected operation parameters compared to the standard BFIz type inverters, and are dedicated to operation in facilities that require the highest reliability and highest quality power supply parameters. Significantly higher-than-standard short-circuit current parameters (up to 9×In) ensure highly selective tripping of protection in distribution boards supplied by the inverter's voltage. The systems operate in a basic online configuration. The HC inverter is characterised by a high overload capacity, which is particularly required when supplying loads of high start-up currents (e.g., electric motors), and a high crest factor (up to 5:1) particularly important when supplying pulse loads.

In contrast to inverter systems, the UPS system also has its own battery, which is charged by the PBI type buffer rectifier. Use of the buffer rectifier instead of the inverter power supply unit to charge the battery depends on the battery's life. Depending on the capacity of the battery selected according to the requirements of the client, the UPS system may have more than one PBI type rectifier module, which will impact the overall dimensions of the finished device.

Moreover, depending on the requirements of the project and/or the battery type, may be situated in a battery cabinet or on a battery rack. In the case of UPS systems of low power and battery capacity, the battery may be placed in the UPS cabinet.

UPS SYSTEM – TECHNICAL CHARACTERISTIC – STANDARD PARAMETERS

PARAMETER		VALUE
AC POWER SUPPLY OF THE UPS SYSTEM (mains)*		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		+10 % to -15 %
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
DC POWER SUPPLY OF THE UPS SYSTEM		
Input voltage		24 / 48 / 60 / 110 / 220 / 400 / 700 V
Input voltage tolerance		±15 %*
AC POWER SUPPLY OF THE BYPASS (backup mains)**		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		±15 %
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
AC OUTPUT OF THE UPS		
Output voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Output voltage frequency		50 / 60 Hz*

UPS SYSTEM – TECHNICAL CHARACTERISTIC – STANDARD PARAMETERS – CONTINUED

PARAMETER	VALUE
AC OUTPUT OF THE INVERTER	
Voltage stability (static)	±1 %
Voltage stability (dynamic)	± 5 % within 10 ms
Voltage waveform	sinusoidal
THDu voltage distortion (linear load)	<2 %
THDu voltage distortion (non-linear load)	<5 %
Output voltage frequency tolerance	±0.1 %
Overload capacity at resistance load	<110 % constant, ≤125 % 10 min, ≤150 % 1 min (<110 % constant, ≤125 % 10 min, ≤250 % 15 s for the HC version)***
Short-circuit current	3×In (up to 9×In for the HC version)***
Crest factor	3:1 (optionally up to 5:1)
Cos φ range	from 0.7 to 1.0
Inverter efficiency	85 to 95 %
Electromagnetic compatibility	EN IEC 62040-2
Available menu language versions	PL | EN | CZ | RU
AC OUTPUT OF THE STATIC SWITCH**	
Frequency synchronisation range	±5Hz or ±3Hz
Switching time: synchronised lines	up to 5 ms
non-synchronised lines	up to 10 ms
Short-circuit current	3kA (max. efficient value)
Power losses	<2 %
Bypass system efficiency	>99%
DC OUTPUT OF THE BUFFER RECTIFIER	
Output voltage	24 / 48 / 60 / 110 / 220 / 400 / 700 V
Output voltage stability**	±0.6 %
Output voltage ripple****	±0.6 %
Range of correction of the buffer charging voltage	between -10 and +50 °C
Temperature compensation of the buffer charging voltage**	0 to 10 mV/°C/cell
Overload capacity	1.1×In for 3 sec
Output current stability***	±1 %
Output current ripple***	±1 %
Battery charging characteristics	IU as per DIN 41773
Battery charging mode: buffer	2.2 to 2.4 V/cell
automatic	2.4 V/cell
supervised	2.7 V/cell
BATTERY	
Battery technology	VRLA: AGM / GEL / Ni-Cd
Voltage of 1 monoblock	2/6/12V
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front*
Cable entry	from the bottom / from the top****
Maximum height above the sea level without change of the rated parameters	1,000 m ASL
Anti-seismic design	up to 6 MSK (up to 9 MSK for the HC version of the inverter)***

* – it is possible to design different parameters upon agreement with the manufacturer;

** – only for the UPS systems equipped with the Static Switch bypass system (SKB or MWB);

*** – see chapter "Inverter module of increased short-circuit current"

**** – only for installation in the industrial cabinet (MS enclosure type).

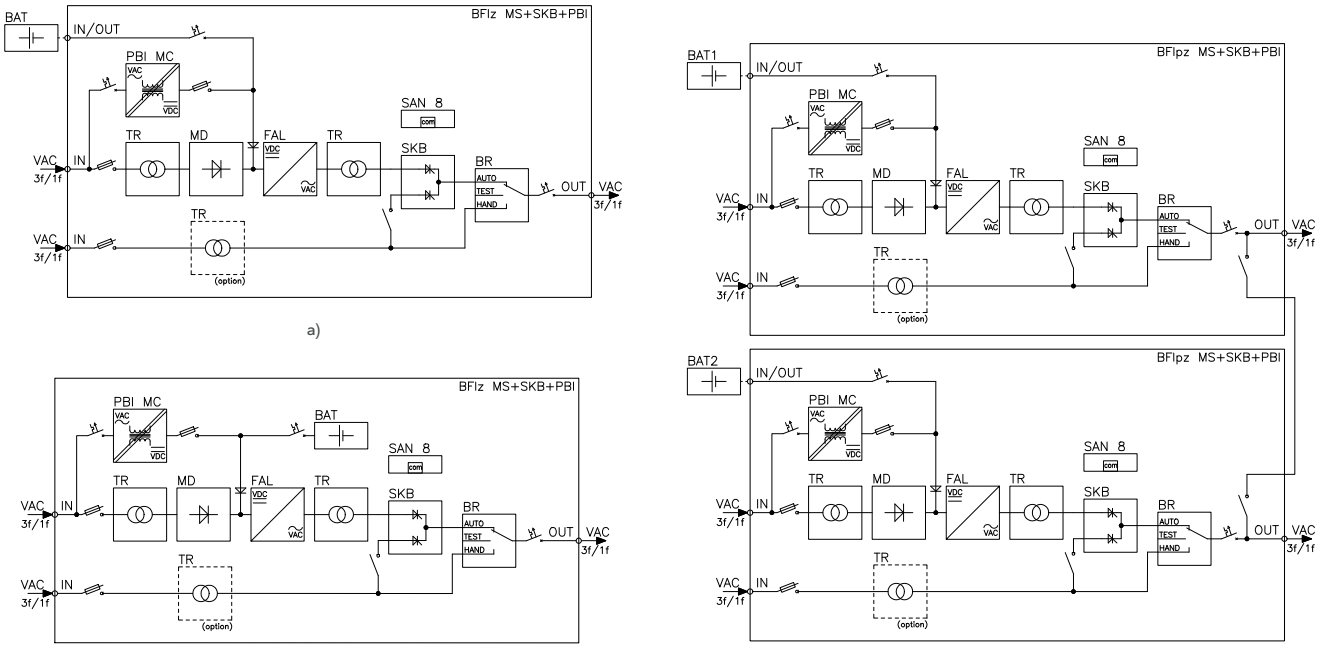


Fig. 87. Block diagram of the UPS system cabinet:
a) for autonomous operation based on the BFIz inverter cabinet with an external battery;
cabinet with a battery inside the UPS cabinet;
erter cabinet with an external battery.

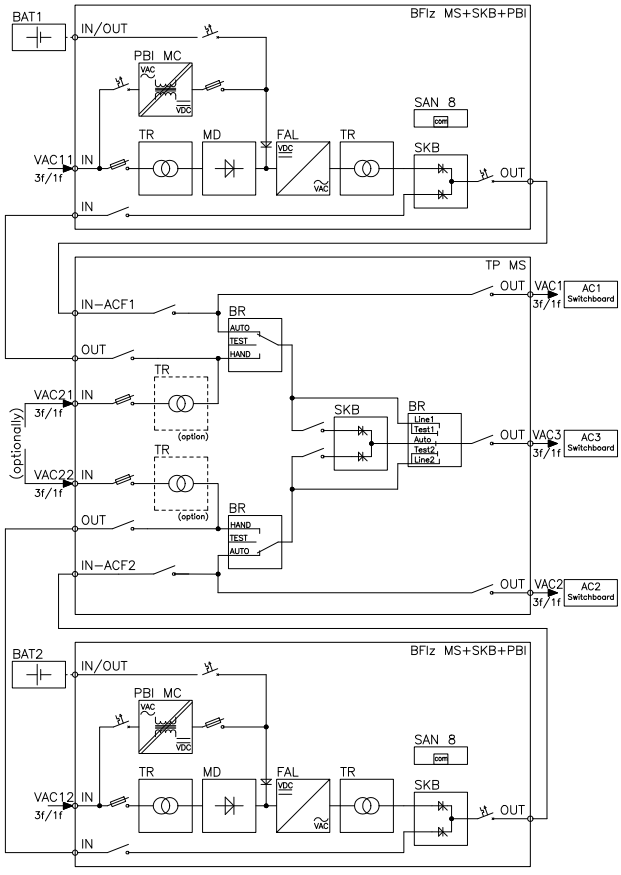


Fig. 88. Block diagram of the UPS system cabinet with an additional SKB system in the TP cabinet.

The UPS system layout presented in Fig. 88 is a special case. This system consists of two inverter cabinets with own automatic bypasses and batteries with the buffer rectifiers to charge them and an additional TP type switching cabinet which contains the SKB type Static Switch system.

Each UPS cabinet operates in the autonomous mode to supply its own section of loads with the guaranteed AC voltage. The additional Static Switch system in the TP cabinet plays the role of the "third line" and ensures an uninterrupted operation of the electric devices of its own section of loads in the case of voltage break in one of the power supply fields.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BAT – battery	PBI – rectifier
BR – maintenance bypass	SAN 8 – console
INV – inverter	SKB – automatic bypass
IN – power supply	TR – transformer
com – communication	VAC – alternating current (AC)
MD – diode bridge	VDC – direct current (DC)
OUT – output	

UPS SYSTEM EQUIPMENT:

1. MAIN AC/DC/AC POWER CONVERTER – THE BFIz TYPE INVERTER

The double power conversion system (classification according to EN 62040-3 – VFI), which converts alternating current to direct current to supply the intermediate DC voltage bus and generate a pure alternating voltage sinusoid of high own output electric parameters adjustment regime.

Components:

DSP microprocessor controller: Inverter control, operating parameters configuration, alarm states indication, external communication;

Power supply system: Depending on the type of the battery and the requirements of the client, it may have a form of a 6-impulse or 12-impulse rectifier or an active power supply with sinusoidal current draw.

Voltage inverter: A converter controlled on the basis of IGBT transistors with the Pulse Width Modulation in standard or special HC design;

Isolating output transformer: Galvanic isolation of primary and secondary voltage circuits.

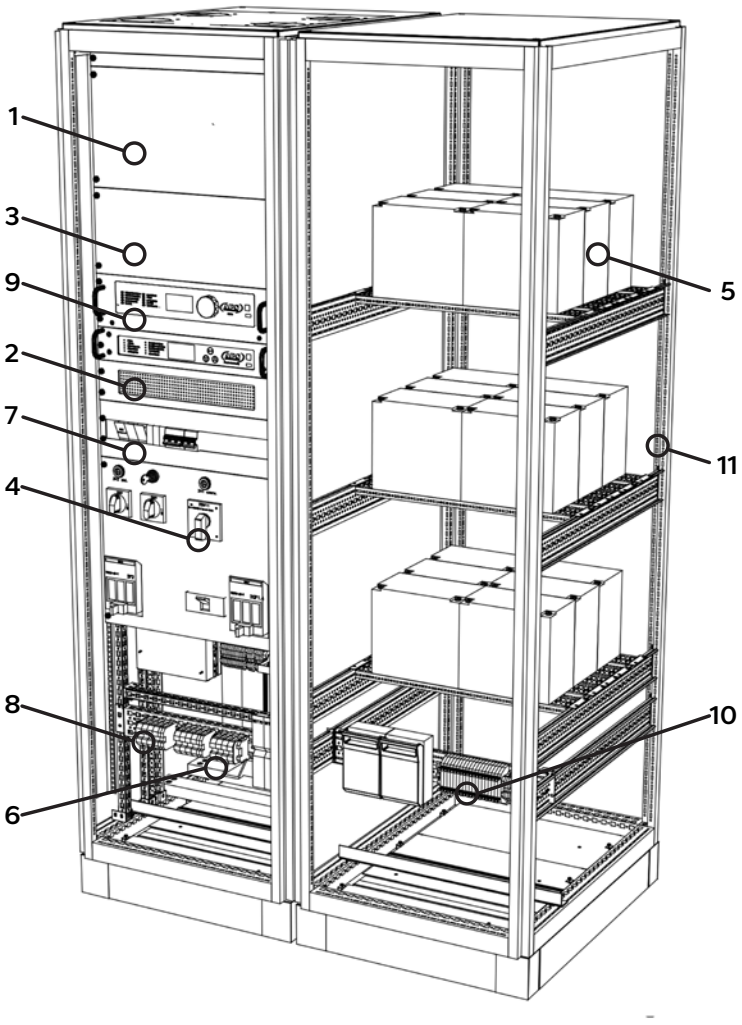
2. BATTERY RECTIFIER

The PBI type transistor, autonomous, dedicated pulse battery rectifier guarantees perfect battery charging and operating parameters. The standard time until achieving full battery charge up to 6–8 hours; the time may be adjusted by the user.

Components:

DSP microprocessor controller: Inverter control, controlling the battery charging process (in accordance with EUROBAT), an active dynamic battery recharging algorithm, battery temperature regulation, and charging voltage temperature correction. Adjustment and limitation of the battery charging current, control of the battery state. Configuration of the operating parameters, indication of the alarm states of the rectifier.

Console (AC-CON): The console consists of an LCD, LED synoptic, and a three-button keyboard or a digital potentiometer. The console informs the personnel about the state of the battery and operation of the converter.



3. BYPASS SYSTEM

The internal connections and switches system that allows feeding voltage from the reserve mains to the circuits of the loads, bypassing the UPS in the case of failure or to carry out checks or other maintenance activities.

Components:

The SKB (Static Switch) automatic bypass: The microprocessor bypass system ensuring uninterrupted (<5 ms) switching of circuits to supply from a reserve network in emergency situations. Voltage on the reserve line is measured continuously; switching to the reserve line is allowed when the parameters are within the tolerance.

Components:

- DSP microprocessor controller,
- non-contact switching thyristor links.

4. MAINTENANCE BYPASS

A mechanical power source switch of such a layout of contacts and guides is used to ensure that switching to reserve power supply (bypass) lines takes place in an uninterrupted manner.

5. ACCUMULATOR BATTERY

The accumulator battery is a reserve (emergency) source of power for the UPS. Sealed, unattended VRLA type batteries in 12V blocks are most commonly used. In the BFIz type industrial UPS systems, it is possible to use various types of batteries depending on the type of electrolyte: (AGM, GEL, liquid electrolyte) or depending on the technology (acid and lead, Ni-Cd, other). The battery consists of cells connected in series in a single or multiple chain. The capacity of the battery may be selected in a wide range from 10 Ah to 1,000 Ah. The time of autonomous battery operation may last from several minutes to several hours depending on the UPS power and the battery's capacity.

Most commonly, the rated accumulator battery voltage is 220 V DC; depending on the project, it may be 700, 400, 110, 60, 48, 24 V DC.

The accumulator battery is protected by a double-pole fuse disconnecting switch.

6. CONNECTION TERMINAL

It contains power line and output circuits connections appropriate for the designed current and wiring.

7. PROTECTION FIELD

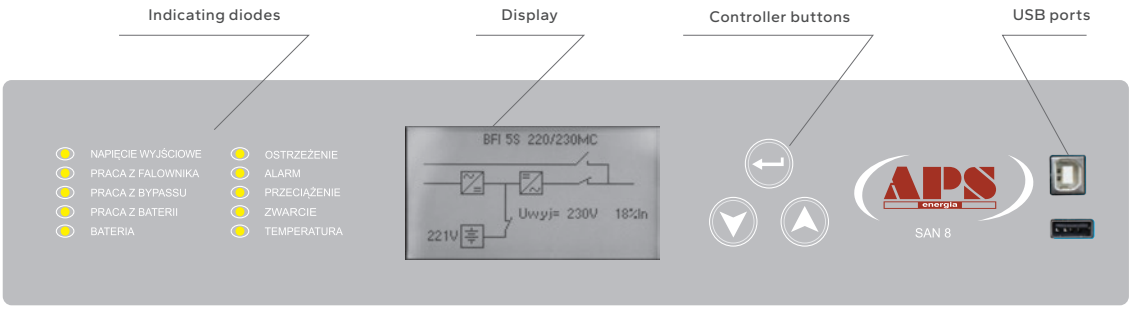
Includes over-current and over-voltage protections.

8. BINARY SIGNALS TERMINAL

The UPS BFIz inverter and rectifier are equipped with binary inputs and outputs, and an auxiliary voltage source that feeds signals to these inputs. Potential-free contacts transfer binary information about the state of the device, operating conditions, and alarms. You may assign different functions to the binary inputs to change the operation of the inverter and the rectifier.

9. SAN 8 AUTOMATIC MONITORING SYSTEM

The SAN 8 monitoring section ensures monitoring, recording, and visualisation of all system operating states, and alerts in case of alarm conditions. Indication of alarm conditions is implemented by potential-free contacts and transmission of data via RS, LSN communication ports using transmission protocols. The communication console presents current parameters and voltage and output currents, voltages of the mains, the battery's voltage and current, the ambient temperature, and data important from the point of view of the reliability of the system.



View of the UPS system SAN 8 console

10. ACCUMULATOR BATTERIES VOLTAGES TERMINAL

To facilitate the assessment of the state of the battery, and, in the case of damage, locate the defective cell, the voltage of each cell is output to the battery voltages terminal. The terminal enables quick measurement of voltage at each cell.

11. ENCLOSURE

Industrial cabinet (one or several). The structure of the cabinets is welded and protected against corrosion with metallic coatings and powder coating.

EMI FILTERS

Single- or multi-stage filters at the input and output of each element of the system reduce the level of conducted disturbances, limit the UPS's disturbance emissions, and improve the resistance to disturbances of the device itself.

PROTECTIONS:

- Over-voltage (B+C), over-current, short-circuit protections, etc.
- Protection against excessive discharge of the supply battery.
- Protections of the internal systems against:
  - increase of voltage on the transistors;
  - power surges caused by dynamic changes of the load;
  - internal short-circuits.

COOLING SYSTEM

The systems are cooled by air circulation forced by roof fans; the air flows into the device through the air inlet located in the lower part of the enclosure. Air filters are located directly behind it. The multi-stage rotational speed is adjusted by the internal temperature function of the device. Additionally to the ventilation, each module is independently cooled with own fans.

SPECIAL DESIGNS OF THE UPS SYSTEM

Special designs:	Upon request, it is possible to adapt the devices to special requirements of a given project in relation to:
	• greater powers of the UPS;
	• the range of the DC rated voltages of the battery;
	• standard of the AC voltages and frequencies;
	  • single-phase inverters: (110 V, 115 V, 120 V, 127V, 50 / 60 Hz);
	  • three-phase inverters: : (3×190 V, 3×200 V, 3×208V, 3×220 V, 50 / 60 Hz);
	• extension of the range of AC input voltages;
	• environmental requirements related to ambient temperature (-20 °C ÷ +55 °C), presence of aggressive factors, etc.;
	• enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.;
	• measurements and communication: digital or analogue meters of appropriate class, indication of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.

Parallel operation	The BFIz UPS systems may operate in parallel with the current equalisation and network synchronisation functions. Parallel operation of the inverters increases the power and reliability (system's redundancy (n+1)).
Active input filter (sinusoidal current draw from the mains):	To improve the THDi of the current drawn from the mains, you may use a bypass with an active filter. By using this solution, you achieve sinusoidal characteristics of drawing of current from the mains.
The bypass's transformer:	The SKB system reserve network voltage is fed through the isolating transformer (option).
Output circuits distribution board	In the BFIz UPS enclosure, you may separate a space and design a guaranteed AC voltages distribution panel equipped with protections of particular output circuits (option).
The SAN 5-1 autonomous battery module system	The device measures the battery's voltage and current, voltages at particular monoblocks, the battery's temperature, and the ambient temperature. Alarm states are indicated when the values of measurements exceed the threshold values.
ATSE system	The task of the automatics of the automatic reserve tripping (ATSE) is switching the basic power supply to the reserve power supply in the case of break or excessive drop of the voltage in the basic power supply circuit, maintaining full efficiency of the reserve power supply devices. The ATSE automatics is intended to improve the reliability of the ATSE system power supply.
Cable entry from the top	It is possible to design the enclosure in a way to allow cables entering from the top.

SERIES TYPE: 1-PHASE UPS SYSTEM CABINETS 1 ÷ 150kVA FOR AUTONOMOUS OPERATION

Rated output voltage 230 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	3×400 or 230	BFIz 1S 24/230 MS+SKB 1***+ PBI	600×800×2,000
7.5 / 10	60		BFIz 7.5S 60 / 230 MS+SKB 7.5***+ PBI	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10	110 / 220		BFIz 1S 110 / 230 MS+SKB 1***+ PBI	
12.5 / 15 / 20		3×400	BFIz 12.5S 110 / 230 MS+SKB 12.5***+ PBI	
25 / 30 / 40	110		BFIz 25S 110 / 230 MS+SKB 25***+ PBI	1,200×800×2,000
50 / 60			BFIz 50S 110 / 230 MS+SKB 50***+ PBI	1,800×800×2,000
25 / 30 / 40	220		BFIz 25S 220 / 230 MS+SKB 25***+ PBI	800×800×2,000
50 / 60 / 75			BFIz 50S 220 / 230 MS+SKB 50***+ PBI	1,400×800×2,000
100 / 120			BFIz 100S 220 / 230 MS+SKB 100***+ PBI	1,800×800×2,000
140 / 150			BFIz 140S 220 / 230 MS+SKB 140***+ PBI	2,400×800×2,000
50 / 60 / 75	400		BFIz 50S 400 / 230 MS+SKB 50***+ PBI	1,200×800×2,000
100 / 120			BFIz 100S 400 / 230 MS+SKB 100***+ PBI	1,400×800×2,000
140 / 150			BFIz 140S 400 / 230 MS+SKB 140***+ PBI	1,800×800×2,000

* – possible options: 220 / 230 / 240 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm;

*** – a cabinet without the SKB bypass is available as an option;

SERIES TYPE: 3-PHASE UPS SYSTEM CABINETS 1 ÷ 500kVA FOR AUTONOMOUS OPERATION

Rated output voltage 3×400 V AC*

Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	24 / 48 / 60	3×400 or 230	BFIz 1T 24/400 MS+SKB 1***+ PBI	600×800×2,000
7.5 / 10	60		BFIz 7.5T 60 / 400 MS+SKB 7.5***+ PBI	
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10	110 / 220		BFIz 1T 110 / 400 MS+SKB 1***+ PBI	
12.5 / 15 / 20		3×400	BFIz 12.5T 110 / 400 MS+SKB 12.5***+ PBI	
25 / 30 / 35 / 40			BFIz 25T 110 / 400 MS+SKB 25***+ PBI	800×800×2,000
50 / 60 / 75	110		BFIz 50T 110 / 400 MS+SKB 50***+ PBI	1,400×800×2,000
50	220		BFIz 50T 220 / 400 MS+SKB 50***+ PBI	800×800×2,000
60 / 75			BFIz 60T 220 / 400 MS+SKB 60***+ PBI	1,400×800×2,000
100 / 120			BFIz 100T 220 / 400 MS+SKB 100***+ PBI	1,600×800×2,000
140 / 150 / 160			BFIz 140T 220 / 400 MS+SKB 140***+ PBI	2,000×800×2,000
180 / 200 / 220 / 250			BFIz 180T 220 / 400 MS+SKB 180***+ PBI	3,000×800×2,000
300			BFIz 300T 220 / 400 MS+SKB 300***+ PBI	3,600×800×2,000
60 / 75	400		BFIz 60T 400 / 400 MS+SKB 60***+ PBI	1,200×800×2,000
100 / 120 / 140			BFIz 100T 400 / 400 MS+SKB 100***+ PBI	1,400×800×2,000
150 / 160 / 180 / 200			BFIz 150T 400 / 400 MS+SKB 150***+ PBI	1,800×800×2,000
220 / 250 / 300 / 350			BFIz 220T 400 / 400 MS+SKB 220***+ PBI	2,400×800×2,000
400 / 450 / 500	700		BFIz 400T 700 / 400 MS+SKB 400***+ PBI	4,200×800×2,000

* – possible options: 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm;

*** – a cabinet without the SKB bypass is available as an option;

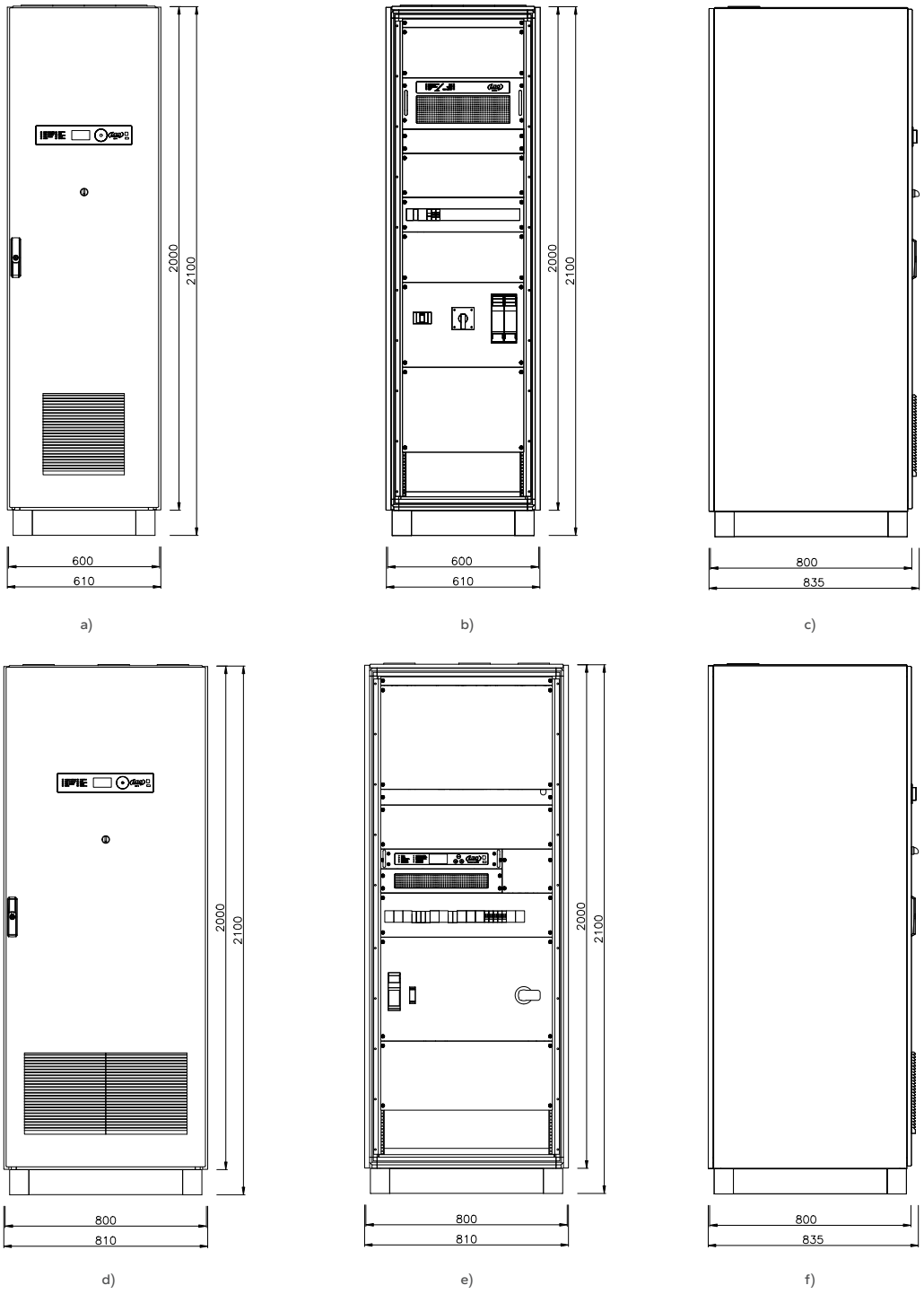


Fig. 89. Views with dimensions of the UPS system cabinet:

a) 600×800×2,000 cabinet – front view, closed door; b) 600×800×2,000 cabinet – front view, open door; c) 600×800×2000 cabinet – left-side view; d) 800×800×2,000 cabinet – front view, closed door; e) 800×800×2,000 cabinet – front view, open door; f) 800×800×2000 cabinet – left-side view.

NON-TRANSFORMER UPS SYSTEMS

UPS MODULA – a modular industrial UPS of sinusoidal current consumption has been constructed on the basis of over twenty years of experience in designing and production of devices for energetics and the industry.

MODULA is intended, among others, for the following types of facilities:

- Data Center,
- Industrial control systems (DCS/PLC),
- Intelligent building systems (IBS).

In economy sectors such as:

- Industry,
- Finances and banking,
- Telecommunications,
- Medicine.

THE CHARACTERISTICS OF THE UPS MODULA:

- the "n+1" redundant configuration is possible by use of a single redundant module;
- high stability of voltage and output frequency, both in steady and dynamic state;
- high efficiency thanks to the capacitive technology;
- data archiving and events buffer on SD card;
- UPS MODULA is equipped in a manual (maintenance) bypass switch. Switching to operation on the bypass line is done in an uninterrupted manner – on/off switch;
- sinusoidal current draw from the mains;
- module design: Hot-Plug;
- RS485, USB and Ethernet integrated communication interfaces;
- high efficiency;
- wide selection of data transmission protocols: Modbus RTU, IEC 60870-5-103, IEC 61850, SNMP; APS6000; other
- SAN 8 microprocessor monitoring of the entire system.

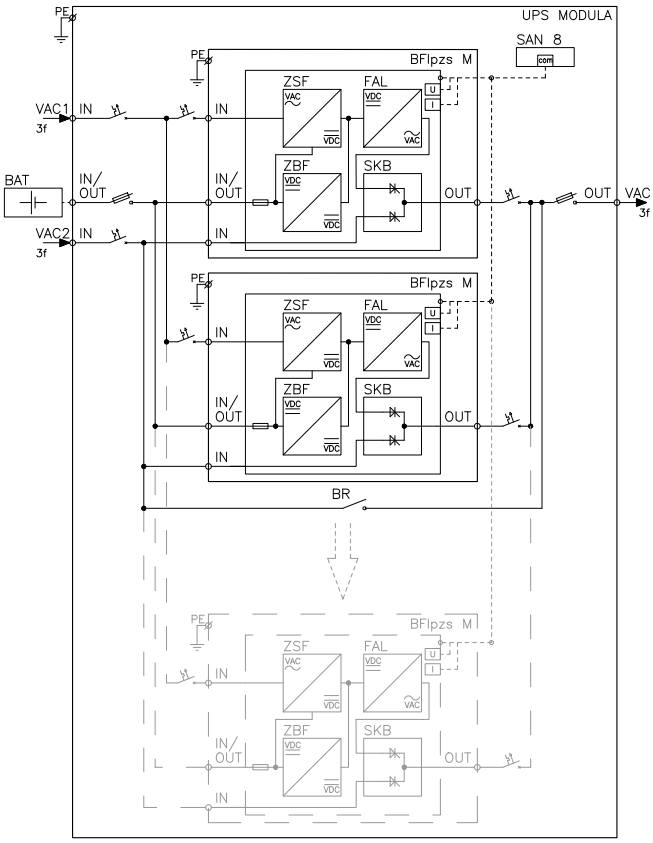


Fig. 90. Block diagram of the UPS MODULA cabinet.

View of the non-transformer UPS cabinet

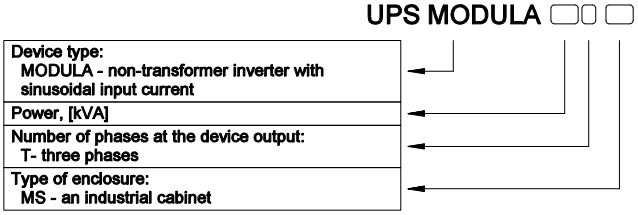
Due to application of active IGBT rectifier, it is possible to draw sinusoidal current from the mains and achieve a high input power factor of 0.99 at rated load. Modular design allows for power configuration from 20 to 120kVA. This functionality allows for expansion of a power supply by further modules without the need to change dimensions of the cabinet infrastructure.

Correct operation is controlled by an automatic monitoring system of the latest generation, designed on the basis of DSP (Digital Signal Processor) microprocessor. Operation of the power supply may be monitored remotely using a delivered software or via communication interfaces in an SCADA type master system.

Each UPS MODULA module constitutes an independent inverter of double AC/DC/AC conversion (as per EN IEC 62040 – 3 VFI) equipped with an automatic bypass (Static Switch) and a battery rectifier.

The module is equipped with short-circuit, over-voltage and temperature protection. Installation of the module in the cabinet does not need screw connectors – it is possible to replace a unit during operation of the entire system (Hot Swap).

METHOD OF DESIGNATION OF THE UPS MODULA SYSTEM:



KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BAT – battery	SAN 8 – console
INV – inverter	SKB – automatic bypass
I – current measurement	VAC – alternating current (AC)
IN – power supply	U – voltage measurement
com – communication	ZBF – inverter's battery power supply
OUT – output	ZSF – inverter's power supply

UPS MODULA – TECHNICAL CHARACTERISTIC – STANDARD PARAMETERS

PARAMETER		VALUE
POWER SUPPLY UNIT		
The maximum power drawn from the AC network at cos φ = 1 (in the battery charging mode)		20kW (the charging current lowers in a way to not exceed 20kW)
The rated power drawn from the AC network at cos φ = 1 (without battery charging)		17 kW
Rated AC input current at φ = 1 (without battery charging)		3×25 A
The maximum current drawn from the AC network at cos φ = 1 (when charging the battery with the maximum current)		3×29 A
Power factor (PF)		0.99 (at load lower than 25 %, PF = 0.97)
AC rated input voltage		3×400 V
AC input voltage tolerance		+10 % to -15 %
AC input voltage rated frequency		50 Hz
AC input voltage frequency tolerance		±5 %
THDi current distortions		<6 % (at load >75 %)
Battery charging current pulsation		<5 A/100 Ah
INVERTER		
Rated output power at cos φ = 0.8		20 kVA / 16 kW
Rated output current at cos φ = 0.8		3×29 A
DC input voltage range		454 to 605 (for 2×126 cells) 475 to 633 (for 2×132 cells)
DC rated current at the input		33.5 A (for 2×126 cells) 32 A (for 2×132 cells) (it also depends on the active power of the inverter)
Rated output AC voltage		3×400 V (with a neutral cable)
AC output voltage rated frequency		50 Hz
Output voltage stability: symmetric load		±1 %
	50 % asymmetrical load	±1 %
	100 % asymmetrical load	±2 %
	dynamic load (step-load up to 100 %)	≤5 %
Adjustment time		20 ms
Change of the electric angle:	symmetric load	<1°
	50 % asymmetrical load	<2°
	100 % asymmetrical load	<3°
Output disruptions (THDu):	linear load	≤2 %
	non-linear load	≤5 %
Crest factor		2:1
Output protection against short-circuit		2×In for 100 ms (without voltage in the bypass circuit) 2×In for 20 ms (with voltage in the bypass circuit)
Inverter overload capability		<101 % constant, 101 to 109% 10 min, 110 to 125 % 1 min
Overheating protection (temperature at the heat sink)		70 °C

UPS MODULA – TECHNICAL CHARACTERISTIC – STANDARD PARAMETERS – CONTINUED

PARAMETER		VALUE
ELECTRONIC BYPASS		
AC rated input voltage		3×400 V (with a neutral cable)
AC input voltage tolerance		+10 % to -15 %
AC input voltage rated frequency		50 Hz
AC input voltage frequency tolerance		±5 %
Rated consumption of current from the mains		3×29 A
Bypass overloading capability		<125 % constant, 125 to 150 % 10 min, 150 to 175 % 1 min
Output protection against short-circuit		3×In for 400 ms
Time of switching from an inverter to bypass		<10 ms
Time of switching from a bypass to inverter		<10 ms
Overheating protection (temperature at the heat sink)		70 °C
BATTERY		
Number of battery elements		2×126 to 2×132
Maximum battery charging current		5 A*
Battery charging current characteristics		IC10
Battery charging voltage in the buffer mode		2.20 to 2.70 V/cell**
Battery voltage temperature compensation		0 to 0.01V/cell/ °C**
Discharged battery minimum voltage		1.50 to 2.30 V/cell**
Voltage stability		±1 %
Voltage pulsation		≤1 %
Charging characteristics		IU as per DIN 41773
GENERAL PARAMETERS		
Efficiency without battery charging:	100 % load	95 %
	75 % load	95 %
	50 % load	95 %
	25 % load	90 %
Cabinet noise level		<74dB (A)
Operating temperature (EN 50178 class 3k3)		+5 to +40 °C***
Storage temperature (EN 50178 class 1k4)		-25 to +55 °C***
Humidity (EN 50178 class 3k3)		5 to 85 % (non-condensing)***
Access to the device		Operation and maintenance from the front***
Cable entry		From the bottom / from the top****
Maximum height above the sea level without change of the rated parameters		1,000 m ASL

* – for the amount of modules n=1, in other cases: I_{MAX}=n×5 A;
** – set by the user;
*** – it is possible to design different parameters upon agreement with the manufacturer;
**** – only for installation in the industrial cabinet (MS enclosure type);

SERIES TYPE: 3-PHASE UPS MODULA CABINETS

Power, [kVA]	Number of modules	Example type	Min. dimensions of the enclosure [W×D×H*], [mm]
10 / 20	1	UPS MODULA 10T MS	600×800×2,000
40 / 60	2 / 3	UPS MODULA 40T MS	600×800×2,000
80 / 100 / 120	4 / 5 / 6	UPS MODULA 80T MS	1,200×800×2,000

* – add the height of the pedestal to the height of the device: by standard, 100 mm.

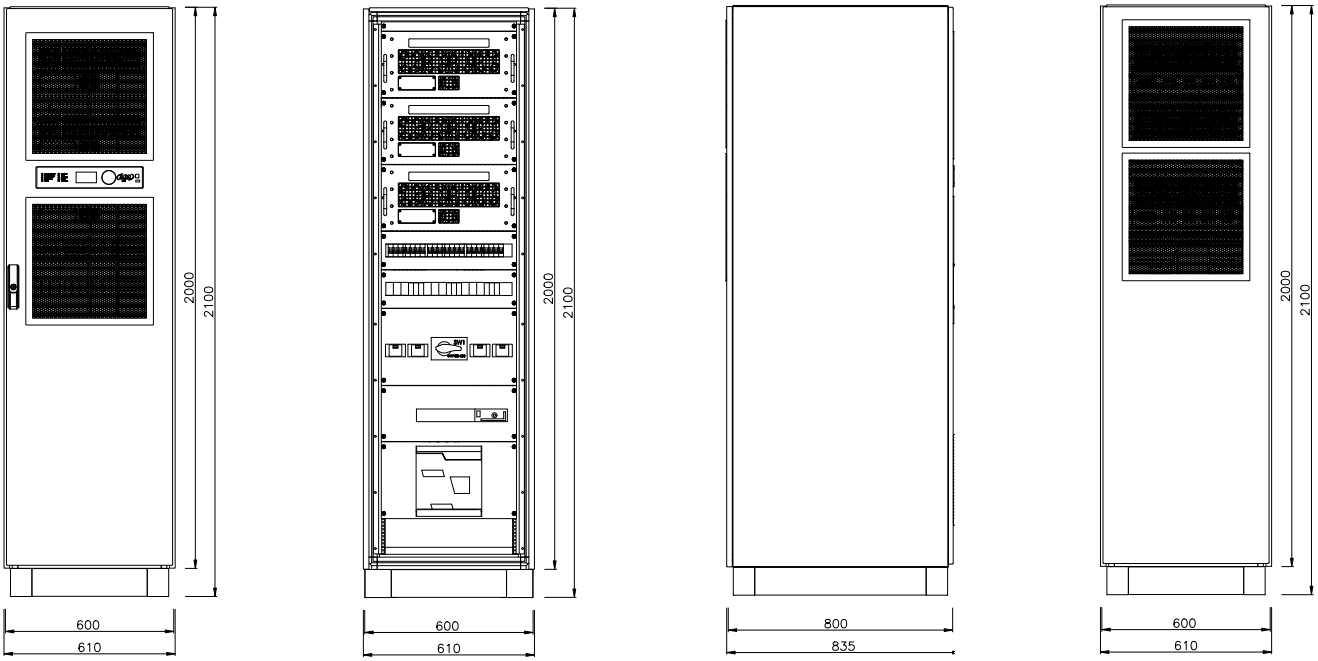
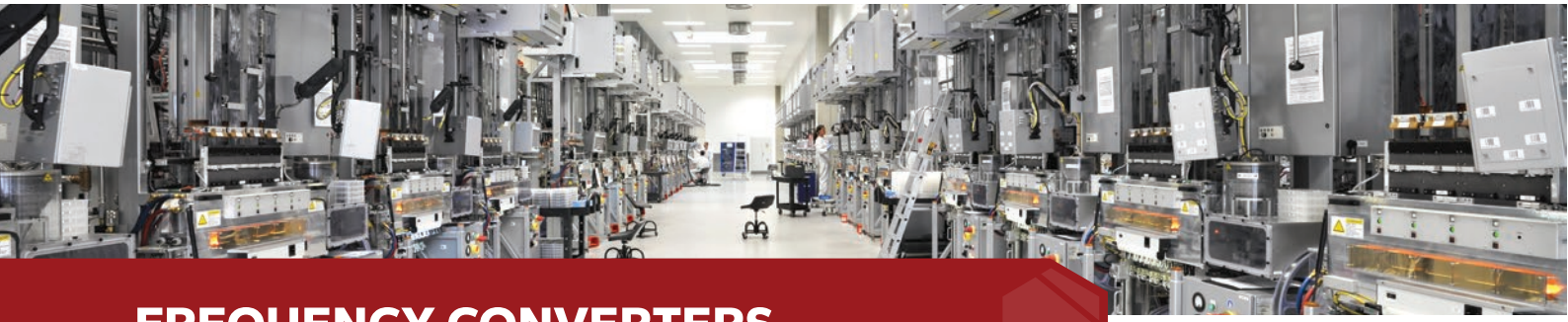


Fig. 91. Views with dimensions of the UPS MODULA cabinet:

a) 600×800×2,000 cabinet – front view, closed door; b) 600×800×2,000 cabinet – front view, open door;
c) 600×800×2,000 cabinet – left-side view; d) 600×800×2,000 cabinet – back view.



FREQUENCY CONVERTERS

The task of the HPI type power supply system is supplying alternating current loads with frequency and voltage different from the mains voltage and (input) frequency. 60 Hz and 400 Hz converters are most often used. The HPI60 converters are used to supply devices, systems, and facilities designed according to the 60 Hz standard. The HPI400 converters are intended for supplying on-board and ground systems in the aviation industry, in military, and to supply specialised industrial instruments, which require power supply frequency of 400 Hz.

It is possible to use the HPI converters with a battery and a rectifier. Such a configuration, together with the HPI converter, will allow obtaining a guaranteed voltage with a specific autonomy time and output parameters different from the power supply parameters.

The HPI frequency converters are intended for facilities that require high reliability and quality of voltage of electrical parameters different from the voltage in the mains.

THE HPI TYPE CONVERTERS CHARACTERISTICS:

- the high-frequency IGBT technology with the Pulse Width Modulation (PWM), microprocessor control (DPS);
- high stability of output voltages;
- very low THDu factor of the output voltage;
- silent operation, small overall dimensions and weight;
- galvanic isolation from the mains;
- EMI filters that reduce the disturbances emitted by the mains and loads, and increase the resistance to disturbances coming from the side of the mains;
- displaying the device operating state on the console – LCD screen and LEDs;
- constant monitoring of the status of all elements of the device, control of their operation and signalling of any failures,

METHOD OF DESIGNATION OF THE HPI TYPE CONVERTERS

HPI□□ □□ □□ □□/□□ □

Device type: HPI - frequency converter	
Types of converters: p - converter for parallel operation za - converter with active power supply unit f - converter with output variable frequency s - converter without galvanic isolation	
Output frequency, [Hz]	
Power, [kVA]	
Number of phases at the device output: S - single phase T- three phases T4 - three phases with N pole (for converters without insulation)	
AC rated input voltage, [V] By standard: 220; 230; 240; 380; 400; 415 Other solutions depend on the order	
	Type of enclosure: M - 19" module without controller MC - 19" module with mounted controller MCE - 19" module with an external console MS - an industrial cabinet CS - standing compact CSE - standing compact with an external console CW - wall-mounted compact CWE - wall-mounted compact with an external console
	AC rated output voltage, [V] By standard: 110; 120; 200; 220; 230; 240; 380; 400; 415; 480 Other solutions depend on the order
	Number of phases at the device input: S - single phase T- three phases

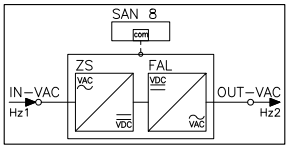


Fig. 92. General block diagram of the HPI type frequency converter

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

INV – inverter	OUT – output
Hz1 – input frequency	SAN 8 – console
Hz2 – output frequency	TR – 50 Hz transformer
IN – power supply	VAC – alternating current (AC)
com – communication	ZS – power supply from the AC voltage
MD – diode bridge	

THE HPI TYPE FREQUENCY CONVERTERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE			
	HPI400	HPI60		
Power	1 to 200kVA	1 to 400kVA	0.5 to 1MVA	2 to 3MVA
AC INPUT*				
AC rated input voltage	1×220 / 1×230 / 1×240 / 3×380 / 3×400 / 3×415 V			3×690 V
AC input voltage tolerance	±15 %		±10 %	
AC input voltage rated frequency	50 / 60 Hz			
AC input voltage frequency tolerance	±5 %			
AC INPUT*				
Rated output AC voltage:	1×220 / 1×230 / 1×240 / 2×110 / 2×120 / 2×200 / 3×380 / 3×400 / 3×415 / 3×480 V			
Shape of the AC output voltage	sinusoidal			
THDu voltage distortion (linear load)	<2 %			
AC output voltage rated frequency	400 Hz	60 Hz		
AC output voltage frequency tolerance	±0.2 %			
It is possible to change the frequency (synchronisation)	±5 %			
Overload capacity at resistance load	<110 % constant, ≤125 % 10 min, ≤150 % 3min		<105 % constant, ≤150 % 30s	
Short-circuit current	3×In*			
Cos φ range	from 0.7 to 1.0			
Total efficiency	>90 %	>92 %		
Crest factor	3: 1		2: 1	
Cooling	air			water
Electromagnetic compatibility	EN IEC 62040-2			
Available menu language versions	PL | EN | CZ | RU			
OPERATING ENVIRONMENT				
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*			
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*			
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*			
Access to the device	operation and maintenance from the front*			
Cable entry	from the bottom / from the top**			
Maximum height above the sea level without change of the rated parameters	1,000 m ASL			

* – it is possible to design different parameters upon agreement with the manufacturer;

** – only for installation in the industrial cabinet (MS enclosure type).

SPECIAL DESIGNS OR EQUIPMENT OPTIONS FOR THE FREQUENCY CONVERTERS

Special designs:	Upon request, it is possible to adapt the devices to special requirements of a given project in relation to: • higher powers of the frequency converters; • standard of the AC voltages and frequencies; • single-phase frequency converters: e.g., 110 V, 115 V, 120 V, 127V, 50 / 60 Hz; • three-phase frequency converters: e.g., 3×190 V, 3×200 V, 3×208V, 3×220 V, 50 / 60 Hz; • extension of the range of AC input voltages; • environmental requirements related to ambient temperature (-20 °C ÷ +55 °C), presence of aggressive factors, etc.; • enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.; • measurements and communication: digital or analogue meters of appropriate class, indication of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.
ATSE system (duplex power supply)	The automatic transfer switching equipment (ATSE) decides about the selection of the source of power for a device. When the source no. 1 supply voltage is present, the HPI type frequency converter is supplied from this source. In the case of break of this source (complete or one of its phases), the ATSE system automatically switches the frequency converter power supply to the source no. 2.
1-phase power supply	By standard, the HPI type frequency converters are equipped with a three-phase power supply unit. For low powers, or in special cases, there is a possibility to use a single-phase power supply.
Protection of circuits at the input and the output	The HPI type frequency converters (AC/DC/AC converter) is a power electronics converter featuring power circuits and output circuits. Over-current protections of those circuits may be incorporated into the device itself or be located in external distribution boards or distribution panels.
Isolating transformer at the input	In the normal operation mode, it is used to ensure galvanic isolation between two internal circuits of the frequency converter and the mains. It allows obtaining increased safety and reliability of the system.
Isolating output transformer	During normal operation, the transformer eliminates the alternating voltage constant component, which is particularly important for supplying loads of inductive nature. In the case of a failure, it isolated AC output circuits from DC circuits, preventing damage to the loads. The transformer is necessary when the IT system power supply (a network isolated to the grounding) is required at the output of the frequency converter.
Parallel operation	It is possible for two or more frequency converter systems to operate on a common guaranteed AC voltage bus. The control algorithm ensures synchronisation of output voltages of particular devices and even power distribution.
Built-in output circuits distribution board	In the frequency converter's enclosure, you may separate a space and incorporate an AC guaranteed voltage distribution panel equipped with protections for particular input circuits.
Active input filter (sinusoidal current draw from the mains)	To limit the introduced disturbances to the mains, you may use a parallel active filter to achieve a sinusoidal characteristics of the current draw from the mains by the frequency converter.
Cable entry from the top	It is possible to design the enclosure in a way to allow cables entering from the top.

FREQUENCY CONVERTERS ARE PRODUCED UPON REQUEST

In the case of atypical or special requirements related to the design, parameters of devices, formal requirements or standards applicable in a given region of the world. Frequency converters produced by APS Energia SA are designed in accordance with the project requirements. Special designs constitute a huge percent of solutions designed and manufactured by APS Energia SA.

MODULAR DESIGN FREQUENCY CONVERTERS

This chapter presents the HPI type single-phase frequency converters in a form of a 19" module of standard 6U height. They are adapted for mounting in industrial cabinets. The main task of the converter is to supply loads with alternating current of the voltage output frequency different from the frequency of the voltage supplying the converter.

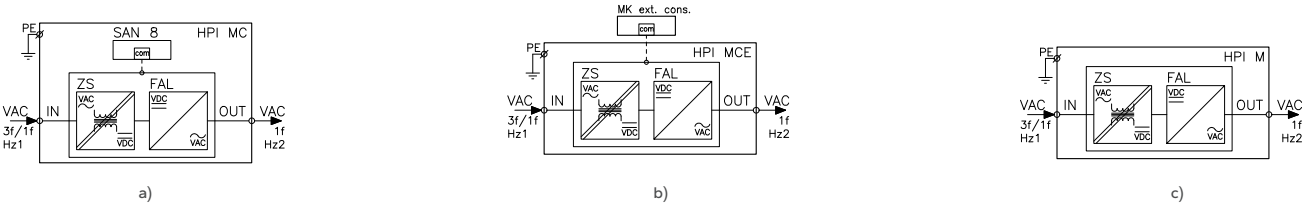


Fig. 93. Block diagram of the HPI type frequency converter module:
a) with a built-in console; b) with an external MK console; c) without a console.

The HPI type frequency converter module is supplied by the AC network voltage. The HPI type frequency converter modules, presented in Fig. 93, are adapted to both autonomous and parallel operation with a device of the same type. By standard, the converter module is equipped with the SAN 8 alternating voltage systems operating parameters control system. The modules with the SAN 8 console belong to the MC modules family (Fig. 93 a), the modules with an external MK console are a part of the MCE modules family (Fig. 93 b), while the modules without the SAN 8 console belong to the M modules family (Fig. 93 c).

The frequency converter's power supply (mains converter) converts the alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the device's circuits at the same time.

The inverter inside the frequency converter converts direct currents into alternating currents of values according to the ordered (by standard, 230 V AC) set output frequency. The galvanic isolation of the HPI type frequency converter's output voltage from the AC supply voltage is ensured by the high-frequency isolating transformer located in the mains converter.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

SERIES TYPE: 1-PHASE FREQUENCY CONVERTER MODULES 1 ÷ 10kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Rated output frequency*, [Hz]	AC rated input voltage, [V]	Rated output voltage** AC, [V]	Example type	Enclosure dimensions***
1 / 2 / 2.5 / 3 / 3.5 / 5	60 / 400	3×400 or 230	230	HPI60 1S 400T/230 MC****	M3
7.5				HPI60 7,5S 400T/230 MC****	M5
10		3×400		HPI60 10S 400T/230 MC****	

* – it is possible to design different parameters upon agreement with the manufacturer;

** – possible options: 220 / 230 / 240 V AC;

*** – M3 (6U): 482×267×496; M5 (6U): 482×267×635. (W×H×D);

**** – possible options: M / MC / MCE.

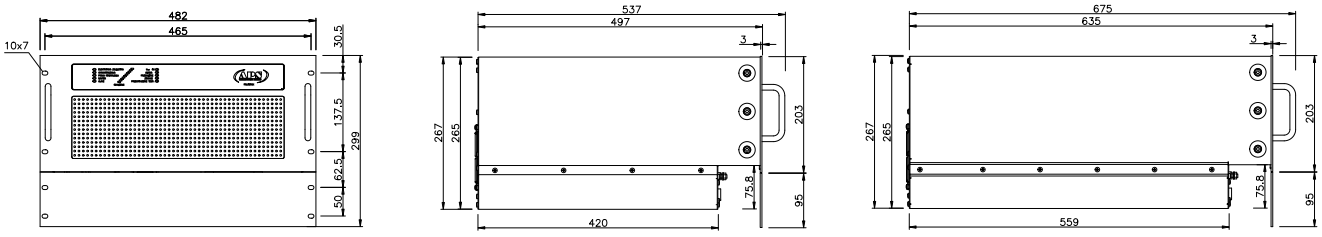


Fig. 94. Views with dimensions of the HPI type frequency converter module:
a) front view in the M3 and M5 enclosure; b) left-side view in the M3 enclosure; c) left-side view in the M5 enclosure.

FREQUENCY CONVERTERS BUILT IN A CABINET

This chapter presents the HPI type 1-phase and 3-phase frequency converters in a form of a 19" industrial cabinet for installation on a substrate. The main task of the converter is to supply loads with alternating current of the voltage output frequency different from the frequency of the voltage supplying the converter.

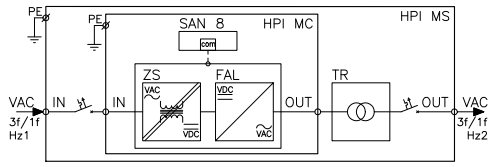


Fig. 95. Block diagram of the HPI type frequency converter cabinet in a modular design.

Fig. 95 presents a standard solution for the HPI type single-phase or three-phase modular frequency converters built in an industrial cabinet. Description of the frequency converter module is presented in chapter "FREQUENCY CONVERTERS IN A MODULAR ENCLOSURE."

The HPI MS type frequency converters consisting of modules are adapted for autonomous operation and parallel operation in the "n+1" system of modules of the same type.

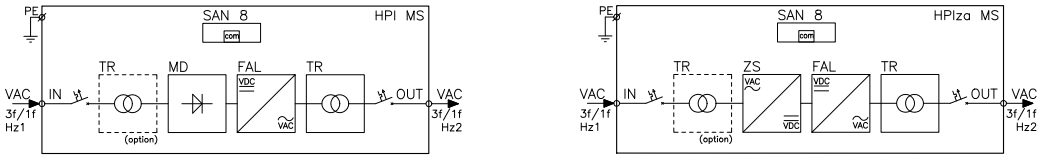


Fig. 96. Block diagram of the frequency converter in a free cabinet design:
a) the HPI type; b) the HPIza type (with an active power supply).

Fig. 96 a) and b) present a standard solution of single-phase or three-phase frequency converters in a free design in an industrial cabinet.

The frequency converter cabinet presented in Fig. 96 is adapted to autonomous operation and parallel operation in a "n+1" design of cabinets of the same type.

The HPI type frequency converter cabinet is supplied by the AC network. By standard, it is equipped with the SAN 8 converter operation parameters control system.

Fig. 96 a) presents a frequency converter with a power supply unit, consisting of a 12-impulse transformer (optionally) and a diode rectifier. The 12-impulse transformer is used mainly to improve the THD value of the current drawn from the mains. Application of a diode rectifier significantly increases reliability of the power supply and desensitises the inverter to any disturbances in the voltage or the frequency of the mains.

The frequency converter converts direct current from the power supply unit to alternating current of a set frequency. This voltage is adapted by the transformer to the value according with the order.

The industrial cabinet is cooled by a forced air circulation via redundant roof fans. Moreover, each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

The HPI400 frequency converter is designed to supply loads with alternating voltage of 400 Hz frequency. The converter converts the 50 Hz frequency supply voltage to another voltage of 400 Hz frequency.

The HPI400 is intended for supplying airport and on-board installations in the avionics industry and is used for military purposes. Thanks to its durability, reliability, and strength, it is intended for operation in difficult environmental conditions, and provides power supply of stable parameters regardless of the quality of the power source.

The HPI may also provide power supply to specialised industrial and laboratory instruments. The advanced EMI filters installed at the input and output of the converter ensure significant reduction of emitted disturbances to the mains and loads, as well as increase the resistance to disturbances coming from the side of the mains.

The HPI60 MS converters are used to provide power supply to entire systems of facilities designed in the 60 Hz standard, e.g., military facilities, technological lines, vessels during standstill in a port, etc.

Thanks to its durability, reliability, and strength, it is intended for operation in difficult environmental conditions, and provides power supply of stable parameters regardless of the quality of the power source.

ADDITIONAL OPTIONS

- Active power supply (sinusoidal current draw);
- Active filter in the AC power supply (improves THDi);
- ATSE (duplex AC power supply);
- Isolating transformer in the bypass circuit;
- Cable entry from the top;
- Special designs – upon agreement;
- Built-in output circuits distribution board – upon agreement;
- High IP.

SERIES TYPE: 1-PHASE AND 3-PHASE FREQUENCY CONVERTER CABINETS 1 ÷ 500kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Rated output frequency*, [Hz]	Rated AC input voltage, [V]	Rated output voltage** AC, [V]	Example type	Min. dimensions of the enclosure [W×D×H***], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5 / 7.5 / 10	60 / 400	3×400 or 230	3×200	HPI60 1T 400T/200 MS	600×800×2,000
12.5 / 15 / 20 / 25 / 30 / 40 / 50 / 60		3×400		HPI60 12.5T 400T/200 MS	
75 / 100 / 120				HPI60 75T 400T/200 MS	1,200×800×2,000
140 / 150 / 160 / 180 / 200	60			HPI60 140T 400T/200 MS	1,400×800×2,000
220 / 250 / 300 / 350				HPI60 220T 400T/200 MS	2,000×800×2,000
400 / 450 / 500				HPI60 400T 400T/200 MS	4,200×800×2,000
140 / 150 / 160 / 200	400			HPI400 140T 400T/200 MS	1,800×800×2,000

All parameters and overall dimensions for frequency converters of power >500kVA are agreed upon individually depending on the client's requirements.

* – it is possible to design different parameters upon agreement with the manufacturer;

** – possible options: see table "THE HPI TYPE FREQUENCY CONVERTERS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS";

*** – add the height of the pedestal to the height of the device: by standard, 100 mm;

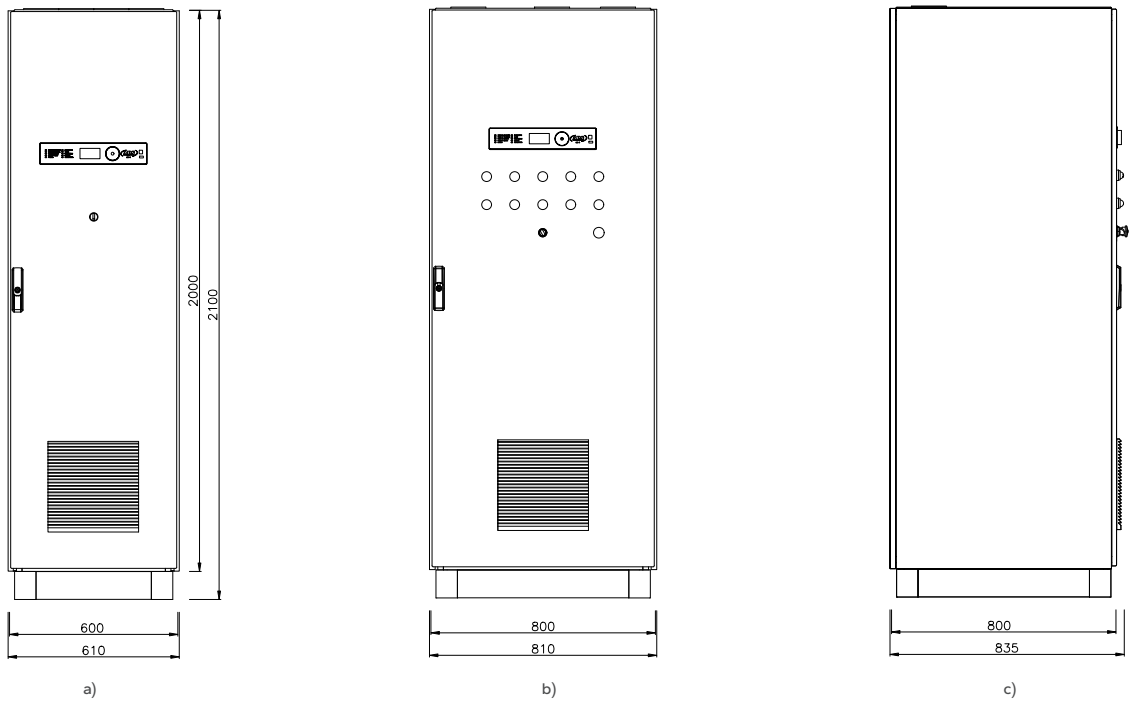


Fig. 97. Views with dimensions of the HPI type frequency converter cabinet:
a) 600×800×2,000 cabinet – front view; b) 800×800×2,000 cabinet – front view; c) cabinet of depth of 800 mm – left-side view.

COMPACT DESIGN FREQUENCY CONVERTERS

This chapter presents the HPI type frequency converters in a compact form. They are intended for installation on a substrate (CS standing compact) or on a wall (CW wall-mounted compact). The main task of the converter is to supply loads with alternating current of the voltage output frequency different from the frequency of the voltage supplying the converter.

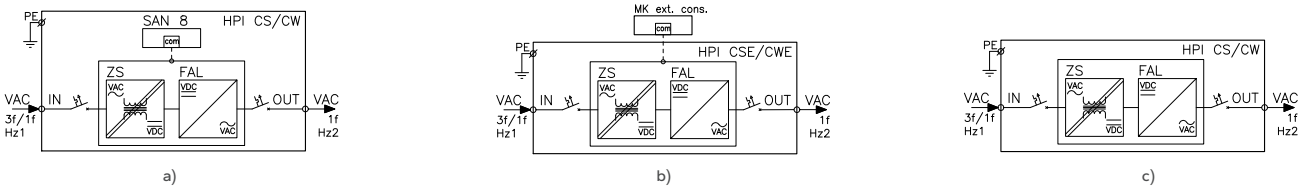


Fig. 98. Block diagram of the HPI type frequency converter compact:
a) with a built-in console; b) with an external MK console; c) without a console.

The HPI type frequency converter compact is supplied by the AC network voltage. The HPI type frequency converter compacts, presented in Fig. 98, are intended for both autonomous and parallel operation with a device of the same type. By standard, the converter compact is equipped with the SAN 8 alternating voltage systems operating parameters control system. Compacts with a built-in SAN 8 console are presented in Fig. 98 a), compacts with an external MK console are presented in Fig. 98 b), and compacts without the SAN 8 console are presented in Fig. 98 c).

The frequency converter's power supply (mains converter) converts the alternating current into direct current necessary to supply the inverter, and ensures galvanic isolation of the network from the device's circuits at the same time.

The inverter inside the frequency converter converts direct voltages into alternating voltages of values according to the ordered set output frequency. The galvanic isolation of the HPI type frequency converter's output voltage from the AC supply voltage is ensured by the high-frequency isolating transformer located in the mains converter.

Each compact is cooled with fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, which significantly increases their lifetime.

SERIES TYPE: 1-PHASE FREQUENCY CONVERTER COMPACTS 1 ÷ 10kVA FOR AUTONOMOUS AND PARALLEL OPERATION

Power, [kVA]	Rated output frequency*, [Hz]	Rated AC input voltage, [V]	Rated output voltage** AC, [V]	Example type	Min. dimensions of the enclosure [W×D×H***], [mm]
1 / 2 / 2.5 / 3 / 3.5 / 5	60 / 400	3×400 or 230	230	HPI60 1S 400T/230 CS****	CS6 / CW6
7.5 / 10		3×400		HPI60 7,5S 400T/230 CS****	CW1

* – it is possible to design different parameters upon agreement with the manufacturer;

** – possible options: 220 / 230 / 240 V AC;

*** – CS6: 500×(2×700)×250; CW1: 800×1,000×300; CW6: 500×700×250. (W×H×D);

**** – possible options: CS / CSE / CW / CWE.

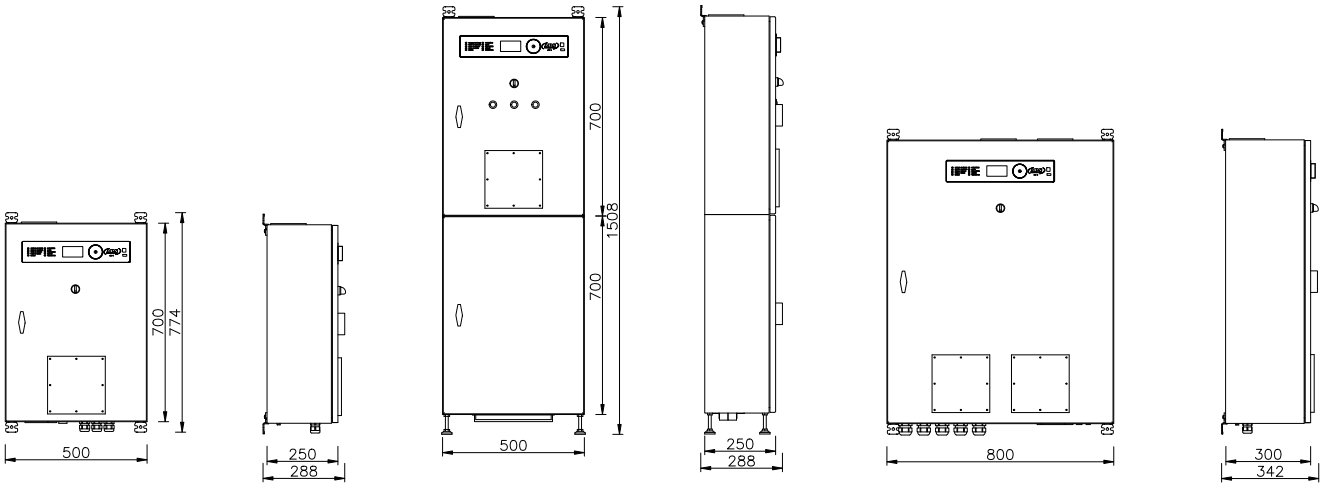


Fig. 99. Views with dimensions of the HPI type frequency converter compact:
a) CW6 compact – front view; b) CW6 compact – left-side view; c) CS6 compact – front view;
d) CS6 compact – left-side view; e) CW1 compact – front view; f) CW1 compact – left-side view.

ASYNCHRONOUS MOTOR POWER SUPPLY SYSTEM

A special type of inverter is a system for powering asynchronous motors – FAT. They also referred to as drive inverters. These inverters are characterised by a possibility to adjust the output voltage frequency. Start-up of an electric motor supplied by FAT is carried out smoothly through frequency adjustment of the motor's rotational speed. These systems may operate with a local or remote control, as well as in a feedback loop, to adapt the motor (pump) parameters to the set operating conditions (pressure, flow). The adjustment of the rotational speed of the motors is a significant source of energy savings in many pump systems. The FAT type inverters, as one of very few on the market, may operate on the direct voltage source (power supply from the direct voltage distribution board or own battery) or alternating current (power supply from a 0.4kV switchgear), thus improving the reliability of the motor's power supply. For this reason, the FAT systems are used to provide power supply to emergency water or oil and lubricating cooling pumps in power plants and heating plants.

CHARACTERISTICS OF THE FAT ASYNCHRONOUS MOTORS POWER SUPPLY SYSTEMS:

- frequency control of motor rotation;
- soft motor start (frequency control);
- low ripple and low level of higher harmonics of the current drawn from the battery (long lifetime of the battery);
- uninterrupted battery switch-over;
- modular design or free design in industrial cabinets;
- controlled by the SAN automatic monitoring system, which ensured monitoring, recording of all device operating states and alarm states in the case of occurrence of an emergency state;
- over-voltage, over-current, short-circuit protection, etc.;
- remote signalling of an alarm status (potential-free relay contacts).

View of the non-transformer UPS cabinet

CHARACTERISTICS OF THE FAT ASYNCHRONOUS MOTORS POWER SUPPLY SYSTEMS:

- motor's rated current;
- motor's rated voltage;
- acceleration time;
- breaking time;
- set frequency;
- set pressure;
- power supply frequency;
  - constant, e.g., 50 Hz;
  - variables in the, e.g., pressure function;
- direction of rotations.

METHOD OF DESIGNATION OF THE FAT ASYNCHRONOUS MOTORS POWER SUPPLY SYSTEMS

FAT□ □□ □□/□□ □

Device type: FAT - drive inverter	
Types of inverters: z - inverter with power supply unit za - inverter with active power supply unit s - inverter without galvanic isolation	
Power, [kVA]	
Number of phases at the device output: S - single phase T- three phases	
	Type of enclosure: M - 19" module without controller MC - 19" module with mounted controller MCE - 19" module with an external console MS - an industrial cabinet
	AC rated output voltage, [V] By standard: 380; 400; 415 Other solutions depend on the order
	DC rated input voltage, [V] By standard: 110; 220; 400 Other solutions depend on the order

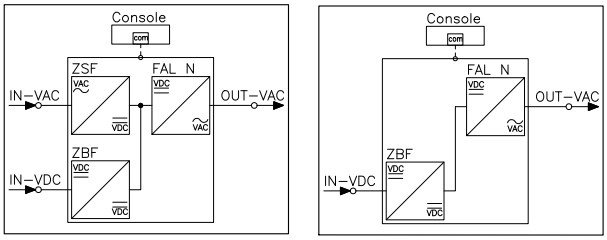


Fig. 100. General block diagram of the asynchronous motor power supply system: a) with the FATz type power supply unit; b) without the FAT type power supply unit.

KEY OF THE ABBREVIATIONS USED IN THE DIAGRAMS IN THE CHAPTER

BAT – battery	OUT – output
INV N – drive inverter	PBI – rectifier
I – current measurement	T – temperature measurement
IN – power supply	TR – 50 Hz transformer
com – communication	VAC – alternating current (AC)
M – motor	VDC – direct current (DC)
MD – diode bridge	ZBF – drive inverter's power supply from the DC voltage

Drive inverters of the FATz / FAT type which used to supply asynchronous motors are dedicated to operate in systems that require high reliability of power supply. These systems are used to:

- ensure uninterrupted operation of the system-critical equipment that is sensitive to power failures and whose disconnection (caused by the mains power failure) could result in significant material damage;
- optimise the system's operating parameters by adjusting the motor speed (power) – a possibility to reduce the energy demand under certain operating conditions;
- provide a soft start for the motor – reduction of the current surges in the motor supply circuits while reducing the shock torques on the motor shaft.

THE FATz / FAT TYPE ASYNCHRONOUS MOTORS POWER SUPPLY SYSTEMS – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER		VALUE
AC INPUT*		
Input voltage:	single-phase	220 / 230 / 240 V
	three-phase	380 / 400 / 415 V
Input voltage tolerance		±15 %
Frequency of input voltage		50 / 60 Hz
Input voltage frequency tolerance		±10 %
DC INPUT		
Input voltage		110 / 220 / 400 V
Input voltage tolerance		± 15 %
AC OUTPUT		
Three-phase output voltage		380 / 400 / 415 V
Output voltage frequency		50 Hz
Frequency control range of the output voltage		0 to 50 Hz*
Motor start-up		(frequency control)
Overload capacity		2×In for 5 sec
Short-circuit current		3×In
Cos φ range		from 0.6 to 1.0
Inverter efficiency		>90 %
Available menu language versions		PL | EN | CZ | RU
OPERATING ENVIRONMENT		
Operating temperature (EN 50178 class 3k3)		+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)		-25 to +55 °C*
Humidity (EN 50178 class 3k3)		5 to 85 % (non-condensing)*
Access to the device		operation and maintenance from the front*
Cable entry		from the bottom / from the top**
Maximum height above the sea level without change of the rated parameters		1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;

** – only for installation in the industrial cabinet (MS enclosure type).

THE FATz / FAT TYPE ASYNCHRONOUS MOTORS SYSTEM EQUIPMENT

1. MAIN DRIVE INVERTER – THE FATz TYPE INVERTER

The AC/DC/AC double power conversion system that converts alternating current into direct current that supplies the intermediate DC voltage bus, and then generates a voltage of variable frequency. The inverter is controlled by a microprocessor (DSP) based on the IGBT transistors with the Pulse Width Modulation (PWM).

Drive inverters without a power supply unit are designated as FAT. A direct voltage source (a battery or a DC distribution board) is the only basic supply voltage of the FAT type drive inverter.

2. AUXILIARY CONVERTERS FOR SUPPLYING THE CONTROL CIRCUITS

By standard, the FATz / FAT system is equipped with a 24 V DC control voltage system.

As an auxiliary system, the following may be used:

- the BFIz / BFI type inverter module for supplying the control circuits with the AC (230 V) alternating voltage;
- the PBI type rectifier module or the EPI type DC/DC converter module for supplying the control circuits with the DC direct voltage (e.g., 220 V).

3. BATTERY RECTIFIER

The PBI type transistor, autonomous, dedicated pulse battery rectifier guarantees perfect battery charging and operating parameters.

4. BYPASS SYSTEM

An internal system of connections including a manual mechanical switch (maintenance bypass) that allows feeding voltage from the mains to the motor's circuits, bypassing the FATz / FAT drive inverter. This switch is used to carry out inspections or other maintenance operations.

5. ACCUMULATOR BATTERY

The reserve (emergency) source of energy of the FATz system is an accumulator battery or DC voltage from the direct current distribution board. For the FAT type systems, the DC voltage is the basic supply voltage.

6. SAN AUTOMATIC MONITORING SYSTEM

The SAN monitoring section ensures monitoring, recording, and visualisation of all system operating states, and alerts in case of alarm conditions. Indication of alarm conditions is implemented by potential-free contacts and transmission of data via RS, LSN communication ports using transmission protocols. The communication console display shows the current parameters of the output voltages and currents, the system's operation synoptic, the voltages of the mains, the battery's voltage and current, the ambient temperature, and other data important from the point of view of the system's reliability.

7. START/STOP SWITCH

Top power supply switch.

8. ENCLOSURE

Industrial cabinet (one or several). The structure of the cabinets is welded and protected against corrosion with metallic coatings and powder coating.

9. COOLING SYSTEM

The systems are cooled by an air circulation forced by roof fans; the air flows into the device through the air inlet located in the lower part of the enclosure. Air filters are located directly behind it. The multi-stage rotational speed is adjusted by the internal temperature function of the device. Additionally to the ventilation, each module is independently cooled with own fans.

Upon request, it is possible to adapt the devices to special requirements of a project in relation to:

- Greater power of the FAT inverter;
- The range of the DC rated voltages of the battery;
- Standard of voltages and frequencies of AC power supply: 3×190 V, 3×200 V, 3×208V, 3×220 V, 50 / 60 Hz;
- Extension of the output voltage frequency range;
- Environmental requirements related to ambient temperature (-20 °C ÷ + +55 °C), presence of aggressive factors, etc.;
- enclosure design, including seismic resistant designs, IP degree of protection, design of the bus bars, access to the cables from the top, coating colour, etc.;
- Measurements and communication: digital or analogue meters of appropriate class, signalling of states, visualisation of operating modes, synoptic of connections, communication protocols, etc.;
- Cable entry from the top (only applies to devices built in the MS cabinet).

MODULAR DESIGN DRIVE INVERTERS

This chapter presents the FATz / FAT type three-phase drive inverters in a form of a 19" module of the standard 6U height. They are adapted for mounting in industrial cabinets. The main task of a drive inverter is to provide constant power supply to an asynchronous motor, with a possibility to adjust the frequency and control the motor's emergency states.

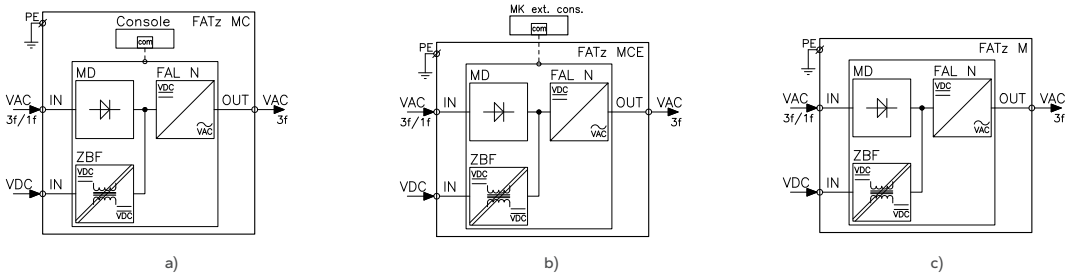


Fig. 101. Block diagram of the FAT type drive inverter module with a power supply unit:
a) with a built-in console; b) with an external MK console; c) without a console.

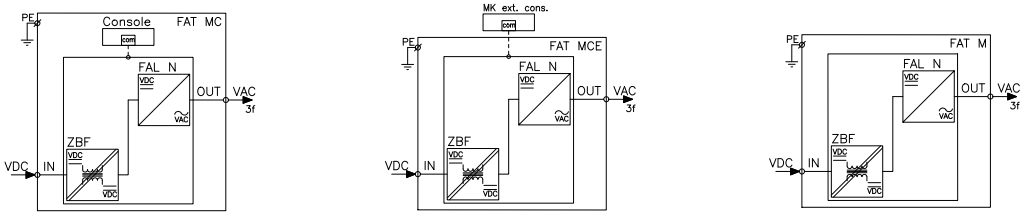


Fig. 102. Block diagram of the FATz type drive inverter module with a power supply unit:
a) with a built-in console; b) with an external MK console; c) without a console.

The FATz drive inverter module is supplied by the voltage of the AC mains and the DC voltage (the battery or the DC distribution board). The FAT type drive inverter module is supplied only by the DC voltage. By standard, the inverter module is equipped with a drive inverter operating parameters control system. The modules with a built-in console belong to the MC modules family – Fig. 101 a), Fig. 102 a), the modules with an external MK console belong to the MCE modules family – Fig. 101 b), Fig. 102 b), and the modules without the console are a part of the M modules family – Fig. 101 c), Fig. 102 c).

The inverter's power supply unit converts the AC network voltage into direct voltage necessary to provide power supply to the drive inverter. Application of a diode rectifier in the power supply unit system significantly increases reliability of the power supply and desensitises the drive inverter to any disturbances in the voltage or the frequency of the mains.

The battery power supply (battery converter) converts the DC supply voltage into direct current necessary to supply the drive inverter, and ensures galvanic isolation of the battery from the inverter's circuits at the same time.

The drive inverter converts direct voltage to alternating voltage of variable frequency.

Each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

SERIES TYPE: 3-PHASE DRIVE INVERTER MODULES 1 ÷ 15kVA FOR AUTONOMOUS OPERATION

Rated output voltage 3×400 V AC*				
Power, [kVA]	DC rated input voltage, [V]	Rated AC* output voltage, [V]	Example type	Enclosure dimensions**
5 / 7.5	110	-	FAT 5T 110 / 400 MC***	M5
5		3×400 or 230	FATz 5T 110 / 400 MC***	
7.5		3×400	FAT 7.5T 110 / 400 MC***	
5 / 7.5 / 10 / 15	220	-	FAT 5T 220 / 400 MC***	
5 / 7.5		3×400 or 230	FATz 5T 220 / 400 MC***	
10 / 15		3×400	FATz 10T 220 / 400 MC***	

* – Possible options: 3×380 / 3×400 / 3×415 V AC;

** – M5 (6U): 482×267×635. (W×H×D);

*** – possible options: M / MC / MCE.

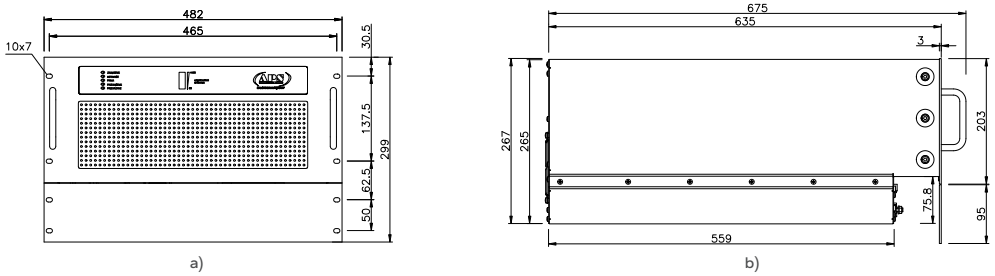


Fig. 103. Views with dimensions of the FATz / FAT MC type drive inverter:
a) front view in the M5 enclosure; b) left-side view in the M5 enclosure.

DRIVE INVERTERS BUILT IN A CABINET

This chapter presents the HPI type 1-phase and 3-phase frequency converters in a form of a 19" industrial cabinet for installation on a substrate. The main task of the converter is to supply loads with alternating current of the voltage output frequency different from the frequency of the voltage supplying the converter.

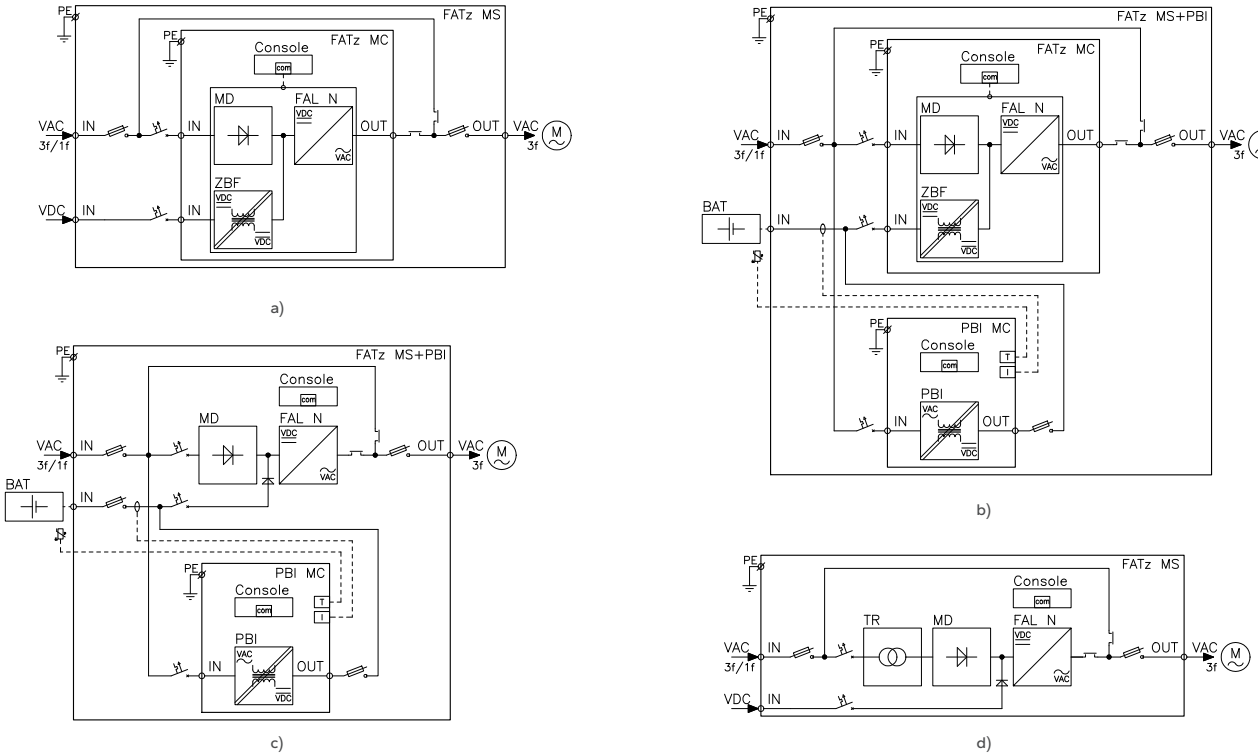


Fig. 104. Block diagram of the asynchronous motors power supply systems:
a) the FATz type (modular design); b) the FATz type (modular design) with the PBI type rectifier module;
c) the FATz type (free design) with the PBI type rectifier module; d) the FATz type (free design).

Fig. 104 a) and b) present a standard solution for three-phase drive inverter modules built in an industrial cabinet. Description of the drive inverter modules is provided in chapter "MODULAR DESIGN DRIVE INVERTERS."

Fig. 104 c) and d) present a standard solution for three-phase drive inverters in a free design in an industrial cabinet.

The FATz type asynchronous motors power supply cabinet system is supplied by the AC mains and the DC voltage (the battery or the DC distribution board) – Fig. 104. An option with only the DC voltage supply is possible. By standard, each system is equipped with a drive inverter operating parameters control system.

Fig. 104 a) presents the simplest solution of the asynchronous motors power supply system, i.e., a cabinet with the drive inverter modules with a power supply unit.

The used buffer rectifier, as presented in Fig. 104 b) and c), ensures charging of the battery, from which DC current is drawn to supply the drive inverter in the case of break of the AC mains voltage.

Fig. 104 d) presents the drive inverter cabinet with a power supply unit, consisting of a transformer and a diode rectifier. Application of the transformer ensures galvanic isolation of DC supply voltage from the AC network, and adapts the AC supply to the needs of the inverter. This transformer may also be used to improve the THD value of the current drawn from the mains (the 12-impulse version).

Application of a diode rectifier in the power supply unit circuit presented in Fig. 104 c) and d) significantly increases the reliability of the power supply and desensitises the drive inverter to any disturbances in the voltage or the frequency of the mains.

The drive inverter converts direct voltage to alternating voltage of variable frequency.

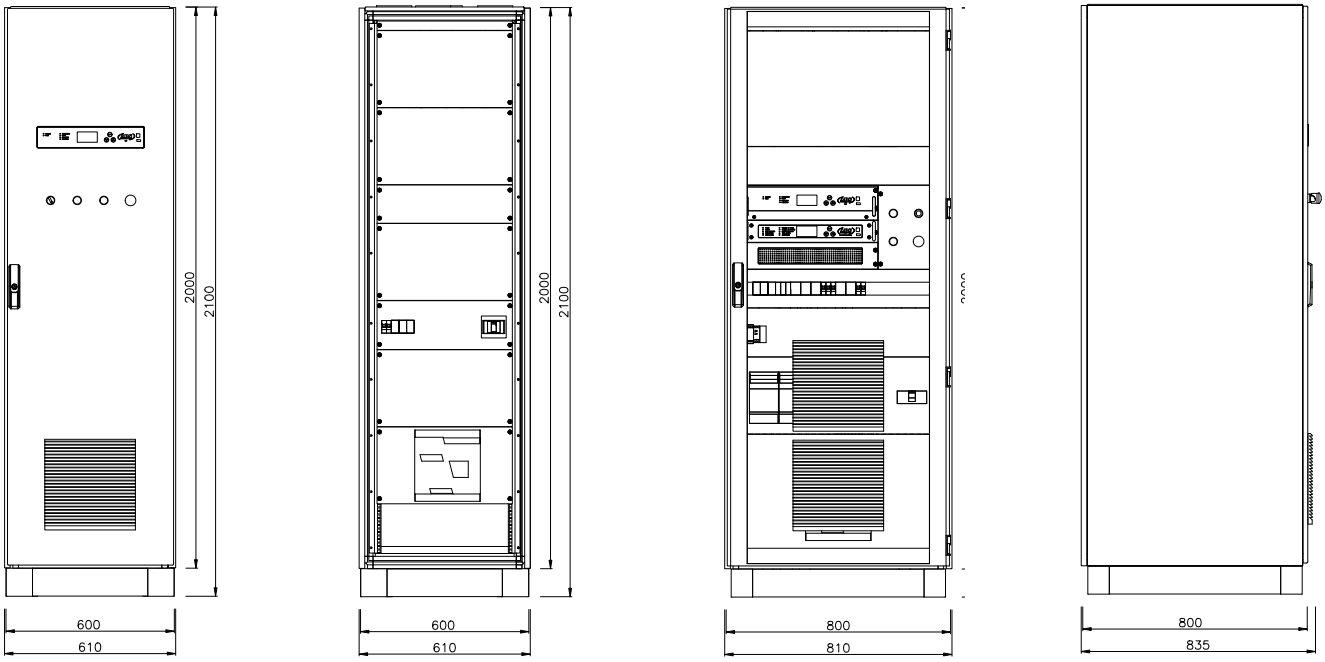
The industrial cabinet is cooled by a forced air circulation via redundant roof fans. Moreover, each module is cooled by fans. RPM of fans is adjusted seamlessly in the external temperature function of the device, significantly increasing their lifetime.

SERIES TYPE: 3-PHASE ASYNCHRONOUS MOTORS POWER SUPPLY SYSTEM CABINETS 1 ÷ 250kVA FOR AUTONOMOUS OPERATION

Rated output voltage 3×400 V AC*				
Power, [kVA]	DC rated input voltage, [V]	AC rated input voltage, [V]	Example type	Min. dimensions of the enclosure [W×D×H**], [mm]
5 / 7.5 / 10 / 15 / 20 / 25 / 30 / 35 / 40	110 / 220	-	FAT 5T 110 / 400 MS	600×800×2,000
5 / 7.5 / 10		3×400 or 230	FATz 5T 110 / 400 MS	
15 / 20 / 30	110	3×400	FATz 15T 110 / 400 MS	
40 / 45 / 55		-	FAT 40T 110 / 400 MS	800×800×2,000
		3×400	FATz 40T 110 / 400 MS	
75 / 100		-	FAT 75T 110 / 400 MS	1,200×800×2,000
		3×400	FATz 75T 110 / 400 MS	1,400×800×2,000
15 / 20 / 25 / 30 / 35 / 40 / 45	220		FATz 15T 220 / 400 MS	600×800×2,000
55 / 75		-	FAT 55T 220 / 400 MS	800×800×2,000
55		3×400	FATz 55T 220 / 400 MS	
75 / 100			FATz 75T 220 / 400 MS	1,200×800×2,000
100 / 150		-	FAT 100T 220 / 400 MS	
125 / 150		3×400	FATz 125T 220 / 400 MS	1,400×800×2,000
55 / 75	400	-	FAT 55T 400 / 400 MS	800×800×2,000
		3×400	FATz 55T 400 / 400 MS	
100 / 125 / 150		-	FAT 100T 400 / 400 MS	1,200×800×2,000
		3×400	FATz 100T 400 / 400 MS	
200 / 250		-	FAT 200T 400 / 400 MS	1,800×800×2,000
		3×400	FATz 200T 400 / 400 MS	2,000×800×2,000

* – possible options: 3×380 / 3×400 / 3×415 V AC;

** – add the height of the pedestal to the height of the device: by standard, 100 mm.



a) b) c) d)

Fig. 105. Views with dimensions of the FATz / FAT type asynchronous motors power supply system cabinet: a) 600×800×2,000 cabinet – front view, closed door; b) 600×800×2,000 cabinet – front view, open door; c) 800×800×2,000 cabinet – front view; d) a cabinet of the depth of 800 mm – left-side view.

MONITORING SYSTEMS AND AUXILIARY DEVICES

PORTABLE CONSOLE

The design of the portable console, also referred to as the MK type external console, allows taking it away from the power device to a specific distance. The purpose of this is:

- Operator safety – taking the console away enables the operator to safely control and manage the device from a remote place, protecting them against direct contact with potentially dangerous equipment;
- Protection against electromagnetic disturbances – the power devices may emit electromagnetic (EMI) or radio (RFI) disturbances, which may impact operation of electric devices, including the console. Placing the console in a certain distance may minimise those disturbances, and thus improve the quality of communication and operating precision;
- Availability in a safe zone – operators may stay in controller and comfort rooms (e.g., the control centre), where they have easier access to the console without the need to enter danger zones, such as halls with large generators or transformers;
- Remote operation – a possibility to bring the console to another building or place allows managing the device without the necessity to be physically present at the installation site, which is convenient in large industrial facilities or expansive sites, e.g., wind farms or power plants;
- Management of multiple devices – in many power facilities, the console is taken to a central location (e.g., a control centre), from where it is possible to monitor and manage many devices at the same time, which is more efficient compared to locally controlling each device separately;
- Integration with SCADA and BMS – a central positioning of the console facilitates integration with the building management systems (BMS) or the SCADA system, which collect and analyse data from many devices, and provides the operators with a full insight into the entire power system;
- Faster response to problems – the console positioned in a central, easily accessible place enables the operators to respond faster to alarms and problems, even when physical access to the device itself is limited or requires time;
- Remote diagnostics and maintenance – taking the console away allows quick diagnosing of problems or even carry out certain maintenance works remotely, which reduces the standstill time;
- Availability in emergency situations – the external console allows quicker disconnecting of the device in emergency situations without the need to be physically present near the equipment, which may be crucial in the case of a failure or a threat to life in the vicinity of the device.

THE MK TYPE PORTABLE CONSOLE CHARACTERISTICS:

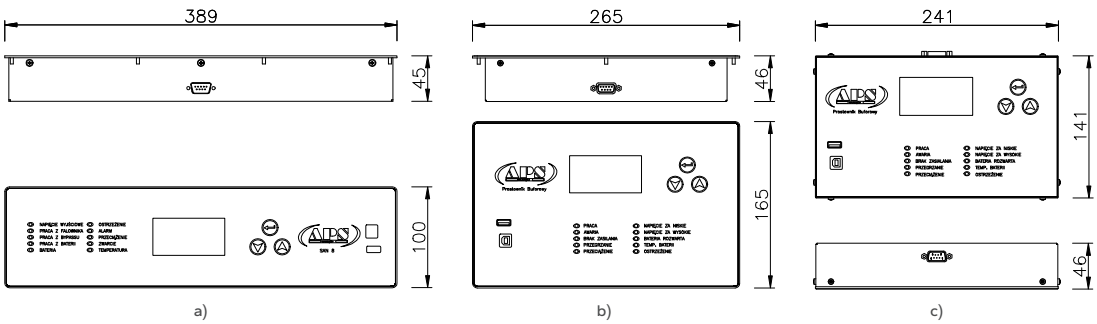
- collecting data;
- creating an event buffer;
- changing the device parameters;
- managing and controlling the device;
- managing the alarms of the device;
- detecting errors and problems;
- integration with the SCADA system;
- updating the software.

METHOD OF DESIGNATION OF THE MK TYPE PORTABLE CONSOLE

MK ☐ ☐

Device type: MK - console module
Cooperation device type: BFI - inverter EPI - DC/DC converters PBI - rectifier Other solutions depend on the order
Type of enclosure: K1; K2; K3.

View of the MK type portable console



a) b) c)

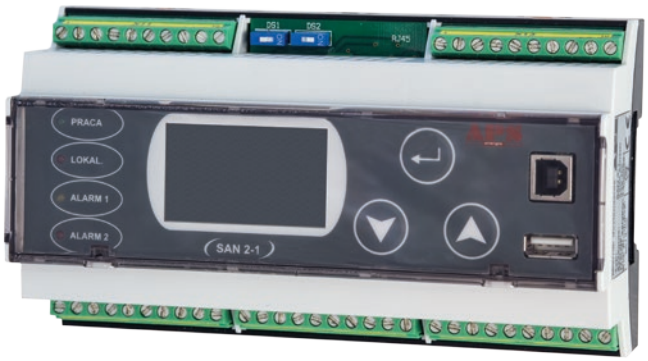
Fig. 106. Views of the MK type portable consoles:
a) K1 console; b) K2 console; c) K3 console.

INSULATION STATE AND EARTH FAULT LOCATIONS SYSTEM

The SAN 2 insulation state control system is intended for monitoring isolated direct current network of rated voltage from 24 V to 220 V. SAN 2 measures the grounding resistance of both poles in relation to the ground potential and localises grounded drains.

The supervision takes place in a continuous manner and current results are presented on the LCD. The system may be fully configured via the user's console. The resistance reduction below the set thresholds is signalled by the turning on of the applicable LED diode and activation of alarm transmitters. All the events are saved in the non-volatile memory of the device which the user has local and remote access to. Integrated communication interfaces RS485 and USB enable configuration and transmission of data to the superior system.

The high-speed microprocessor and powerful measurement algorithms used allow precise and fast measurement of leakage current and location of the faulty drain even in environments with high interference.



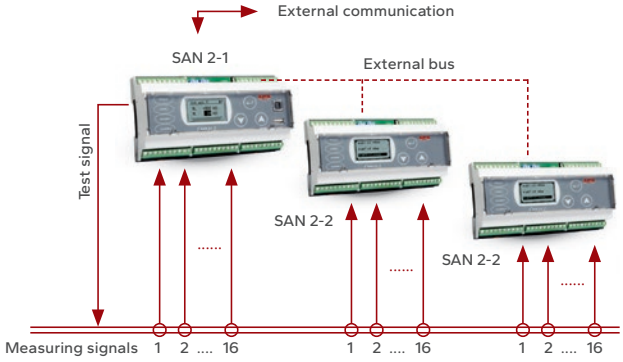
SAN 2 module view

DESCRIPTION OF THE SAN 2 OPERATION

A modular design allows creating a distributed system of monitoring a large number of DC circuits (maximum 1,760 drains). For the purposes of communication between the modules, the internal bus bar which conforms to CAN 2.0 A standard is used.

The SAN 2-1 modules consists of two essential blocks: the earth fault meter and the locator. The earth fault meter block includes a test impulse generator and a control and measuring block which controls the generator's operation based on current measurements and set parameters. The locator in the SAN 2-1 module monitors up to 16 drains.

The SAN 2-2 module is an additional locater of grounded drains. The locator in the SAN 2-2 module monitors up to 16 drains.



The SAN 2 system conceptual design

GROUND RESISTANCES MEASUREMENT FUNCTION

The SAN 2-1 module implements measurement of the resistance of the insulation in two modes:

- the voltage mode (not generating a current signal to the system), the principle of operation is based on the analysis of differences of voltages in the system and the earth fault resistance model;
- the current mode, consisting of an analysis of the periodically generated test signal. Both, the period of the measuring cycle as well as the amplitude of the test signal depend on the configuration of earth fault meter and current network parameters.

Drop of the grounding resistance level below the set threshold trips an alarm. Moreover, the process of tracking of the defective drain is tripped.

THE SAN 2 SYSTEM CHARACTERISTICS:

- the following modules belong to the SAN 2 series:
  - SAN 2-0 – measurement of the ground resistance of both poles,
  - SAN 2-1 (system central unit) – measurement of the ground resistance and monitoring of up to sixteen drains,
  - SAN 2-2 (locator) – supervision of up to sixteen drains;
- the SAN 2-1 central unit includes an insulation resistance measurement block, an earth fault locator (up to 16 drains), and a communication interface;
- a possibility to connect up to 110 SAN 2-2 expansion modules (16 drains each) to the central unit to allow monitoring of up to 1,760 drains;
- constant measurement of the ground resistance of direct current network;
- a possibility to control and limit the voltage differences occurring during tests. ΔV test to not disturb operation of other DC system devices;
- two operating modes: voltage and current;
- quick indication of a drain, the leakage current of which exceeded the defined value;
- configurable amplitude of test current allows for applying the system in the power supply networks for sensitive electric equipment;
- signalisation of alarm conditions (warning and alarm) with the use of LED diodes, messages on the graphic LCD screen and transmitters;
- a possibility to select the communication language in the panel's menu: Polish, English, Russian;
- resistant to disturbances internal bus bar which conforms to CAN standard;
- indication of a lack of connection of the measuring transformer;
- event logging in the internal memory on the SD card;
- integrated RS485 and USB communication interfaces;
- automatic testing of the current transformers during localising the current leakage;
- convenient assembly on the TS-35 bus (DIN).

THE INSULATION CONTROL SYSTEM HAS TWO BASIC FUNCTIONS:

- ground resistance measurement function;
- the shorted circuit tracking function.

DAMAGED DRAINS TRACKING FUNCTION

The locator system is used to measure the leakage current in real-time. Each monitored drain must be equipped with a current transformer connected to an appropriate SAN 2-1 or SAN 2-2 measuring input. For the tripped measurement channel, the current transformer test is carried out before each measurement cycle. If the test result is positive, the collected measurement series is analysed after completion of the measurement cycle.

As a result of the measurement series, the circuit of the largest earth leakage is indicated.

View of the current transformer

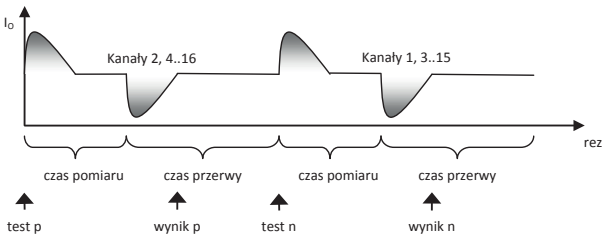
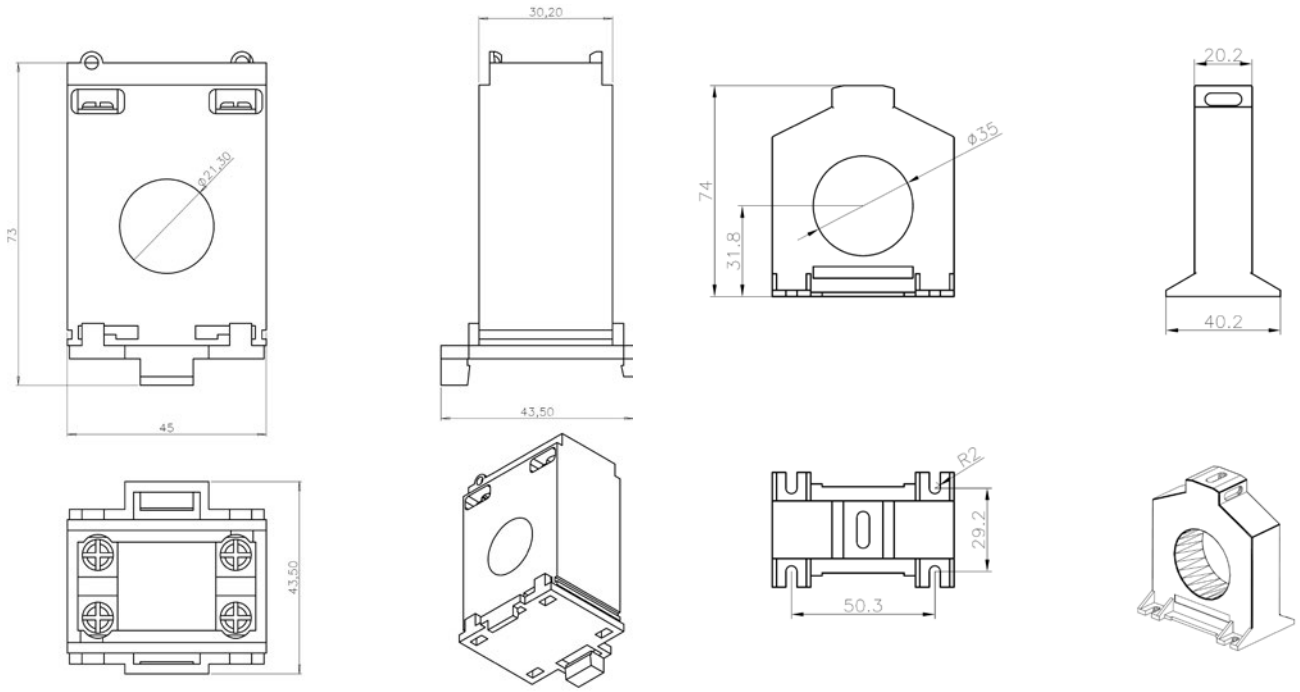


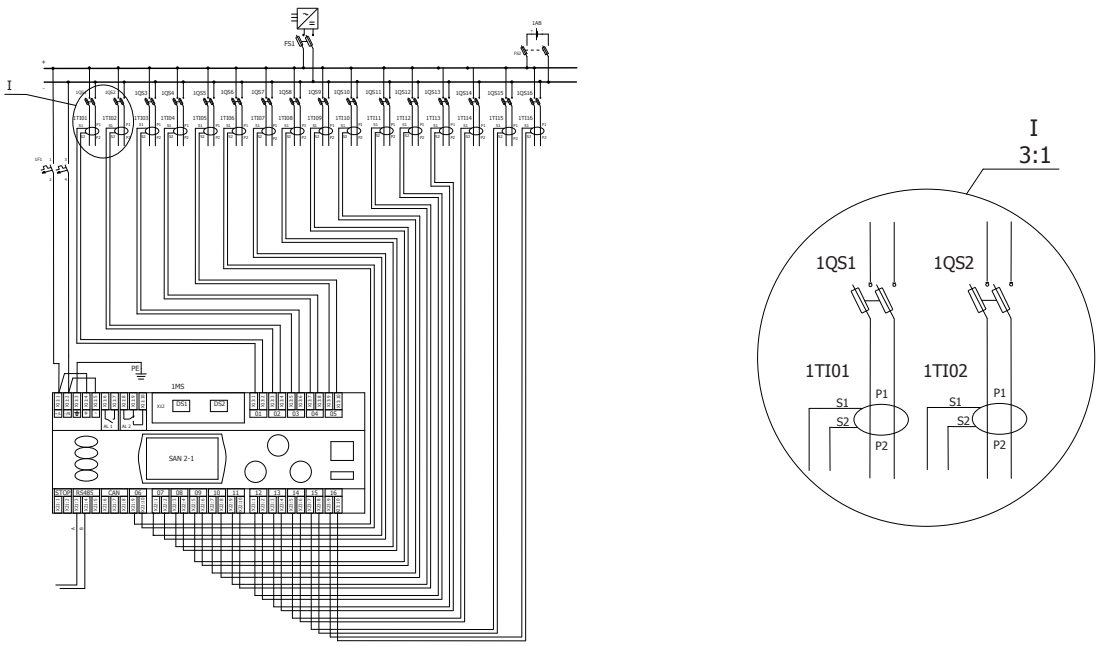
Fig. Locator operation



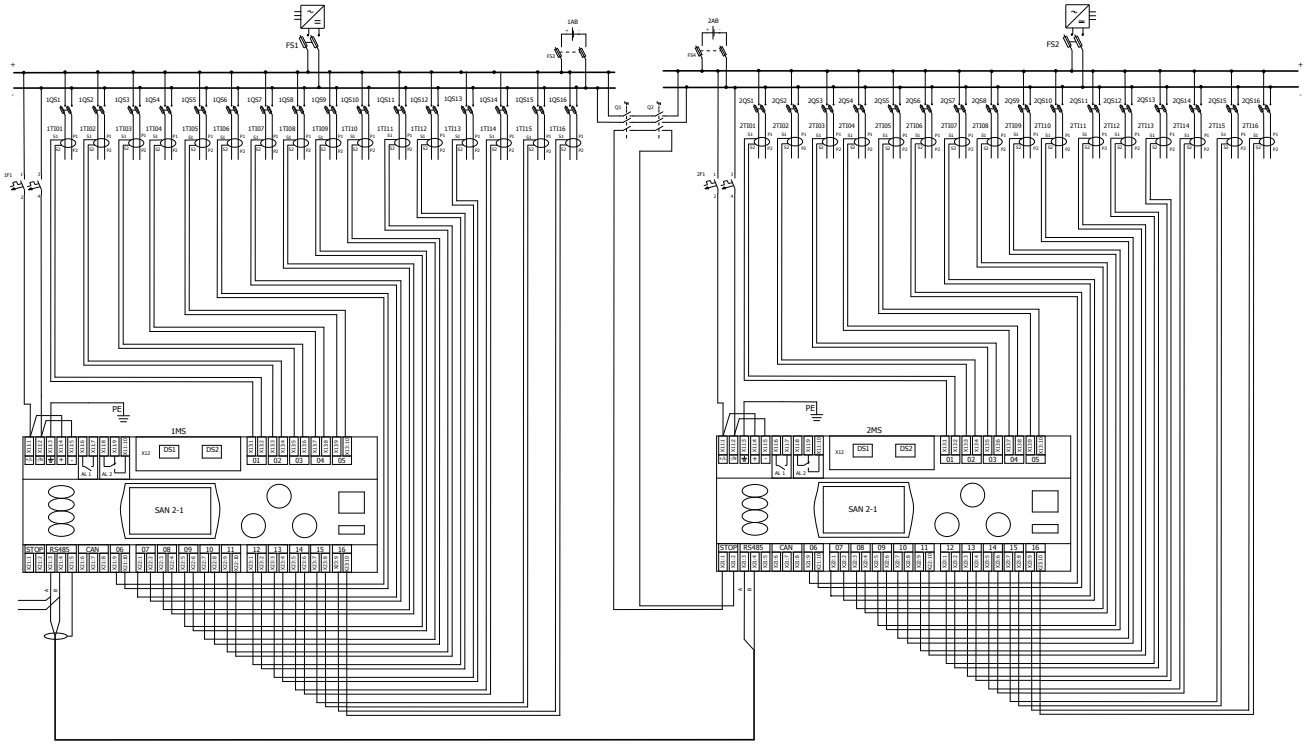
a) b)

Fig. 107. Views with dimensions of the current transformers:
a) the PPU21 type; b) the PPU35 type.

SAN 2-1 WIRING DIAGRAM IN A SINGLE-SECTION DISTRIBUTION BOARD



SAN 2-1 WIRING DIAGRAM IN A DOUBLE-SECTION DISTRIBUTION BOARD



THE SAN 2 TYPE MONITORING SYSTEM – TECHNICAL CHARACTERISTICS

PARAMETER	VALUE	
System power supply	1×220 / 1×230 / 1×240 / 2×120 / 2×230 / 2×480 / 3×380 / 3×400 / 3×415 V	
AC supply voltage frequency	50 Hz (47 to 63Hz)	
Maximum power intake	12VA	
Rated DC measurement voltage	24 / 36 / 110 / 220 V	
Rated power supply insulation voltage: power supply from 12 to 48V DC	1,500 V	
220 V DC / 230 V AC power supply	4,000 V	
Measurement chain insulation voltage: peak value	1,230 V	
within 1 min	5,000 VRMS	
Voltage of the insulation of the interlock input within 1 min	2,500 VRMS	
CAN internal bus bar terminal insulation voltage within 1 min	2,500 VRMS	
RS485 external bus bar terminal insulation voltage within 1 min	2,500 VRMS	
Maximum quantity of modules connected to the internal bus bar	110	
Maximum quantity of monitored drains	1760	
CURRENT TRANSFORMER		
Transformer type	PPU21	PPU35
Internal opening diameter	21mm	35mm
ENCLOSURE		
Enclosure attachment	the 35mm DIN bus or twisting for construction	
Dimensions (W×H×D)	162×89×62mm	
Colour	RAL7035	
OPERATING ENVIRONMENT		
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*	
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*	
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*	
Access to the device	operation and maintenance from the front*	
Cable entry	from the bottom / from the top	
Maximum height above the sea level without change of the rated parameters	1,000 m ASL	

* – it is possible to design different parameters upon agreement with the manufacturer.

SYSTEM OPERATION PARAMETERS MONITORING AUTOMATIC SYSTEM

The SAN 3M automatic monitoring system is intended for monitoring voltages, currents, temperatures, state of the links, state of the battery's operation in direct current or alternating current distribution boards, and in the auxiliary distribution boards. Collected data are analysed, and the monitored facility's operation is controlled on their basis.

View of the SAN 3M module

Measurements and analysis of the measured values are carried out continuously. Use of the precise A/C converters ensures high precision of measurements. The SAN 3M system enables immediate detection of inconsistencies in operation of the distribution boards and informing the user about the occurring alarm states. The controller allows setting the warning and alarm values.

The SAN 3M system features a modular design based on specialised control and measurement cards. The system consists of: a controller with a display, a power supply, a central unit, and from 1 to 8 control and measurement cards. The number of used control and measurement cards depends on the number of signals that must be controlled in the monitored facility.

In installations that require use of a greater number of control and measurement cards or in the case of distributed facilities, it is possible to use multiple SAN 3M modules (this module will operated as a SLAVE, and will not have the controller system with a console).

The power supply used in the system has two inputs with galvanic isolation that allow feeding direct and alternating supply voltages at the same time. For correct operation, feeding one of those voltages is sufficient. Connecting both voltages allows increasing the reliability of the operation of the system (the system operates continuously in the case of break of one of the voltages).

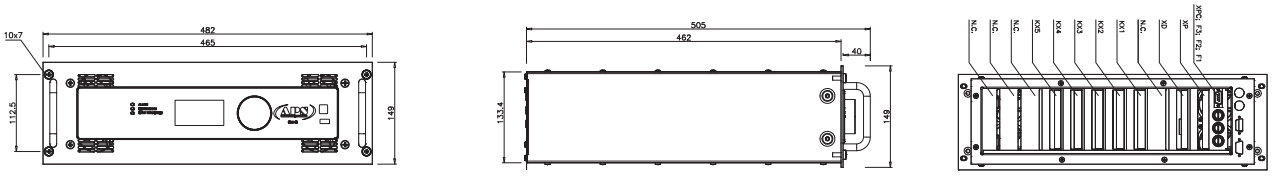
THE MK TYPE PORTABLE CONSOLE CHARACTERISTICS:

- monitoring and analysis all operating parameters:
  - voltage of the bus bars;
  - current of the bus bars;
  - states of the connectors;
- comprehensive supervision of the battery operation:
  - battery voltage control;
  - battery current measurement;
  - multi-point temperature measurement;
- user-configurable warning and alarm threshold values for individual analogue measurements;
- high precision of measurements;
- galvanic isolation of analogue and digital measurements;
- a possibility to communicate with the monitoring system by the insulated communication link;
- archiving of monitored data from measurement cards and external devices in permanent memory (SD card – maintenance option).

THE SAN 2 TYPE MONITORING SYSTEM – TECHNICAL CHARACTERISTICS

PARAMETER	VALUE
Nominal power supply voltage	220 V DC / 230 V AC
Power supply voltage tolerance	±15 %
AC supply voltage frequency	50 Hz
Maximum number of control and measurement cards	8
ENCLOSURE	
Mounting	installation in a 19" industrial cabinet
Dimensions (W×D×H)	482×465×149mm (3U)
Colour	RAL7035
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front
Cable entry	from the bottom and from the top
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer.



a) b) c)

Fig. 108. Views with dimensions of the SAN 3M type automatic monitoring system module:
a) front view; b) left-side view; c) back view (a view of example location of the control and measurement cards).

CHEMICAL BATTERIES MONITORING SYSTEM

The SAN 5-1 (SAN 5-1.3) microprocessor-based system of the autonomous battery module is intended for continuous monitoring of the battery's state. The device measures the battery's voltage and current, voltages at particular battery monoblocks or the battery's symmetry voltage, battery's temperature, and ambient temperature. The measurements are compared with threshold values, and in case of detecting abnormalities in the battery operation, SAN 5-1 signals emergency states.

The primary task of the monitoring system is to detect irregularities in the monitored battery and locate the "weakest" cell.

The built-in LCD allows user communication in two modes:

- displaying the results of measurements of the entire battery and screens with the measurements of voltages of particular cells (monoblocks) or the battery's symmetry voltage;
- displaying an intuitive menu for viewing all current measurements, parameters, system status, and alarm logs. It also enables configuration of the device and its operating parameters.

View of the SAN 5-1 monitoring system

THE SAN 5-1 SYSTEM CHARACTERISTICS:

- high operational stability;
- double measurement system:
- voltages of the entire battery, the battery's temperature, the ambient temperature, etc.;
- voltages of particular cells of the battery chain or the battery's symmetry;
- indication of the following operating states:
  - alarm state;
  - warning;
  - deep battery discharge;
  - system power supply;
  - buffer operation;
  - system operation;
  - battery charging;
  - battery discharge;
- remote indication of an alarm state – potential-free relay contacts;
- visualisation of the measured parameters on the LCD;
- intuitive and easy user interface comprising an LCD, keyboard, and LED lights;
- data archiving – cyclically, according to the set time, the state of the entire system is stored in the read-only memory;
- event archiving – the device records and archives each occurrence and cessation of alarm states, warnings, and system status changes in the permanent memory;
- USB 2.0 port that enables storage of event buffers on a FLASH memory stick (flash drive);
- wide selection of external communication protocols: APS6000, Modbus RTU, IEC 870-5-103. The protocol type selected in the menu:
- a possibility to integrate with another monitoring system via the RS485 link (RS1, RS2).

SAN 5-1 OPERATION DESCRIPTION:

The SAN 5-1 monitoring system is adapted to:

- Configuration 1: measurement of voltages of all measured cells/monoblocks, and the voltage of the entire battery; or
- Configuration 2: measurement of the battery's voltage symmetry and the voltage of the entire battery.

Optionally, the SAN 5-1 may also measure the battery's current, battery's temperature, and the ambient temperature.

When any of the values exceeds the warning or alarm threshold, it is signalled by illumination of an appropriate LED and tripping of a relevant relay output. The current system status is also displayed in a form of messages on the LCD screen. Using the device's menu function, it is possible to display all detailed data about the monitored battery.

Deep discharge status, warnings, and alarms are additionally indicated by LED lights on the device panel.

SPECIAL DESIGNS OR EQUIPMENT OPTIONS:

Upon request, it is possible to adapt the device to special requirements of a given project, e.g.:

- other rated voltage of the battery;
- other supply voltage, e.g., appropriate for the monitored battery;
- other transfer speed on the RS485 serial communication link;
- level of the DC output voltages;
- environmental requirements related to ambient temperature (-20 °C ÷ + 55 °C), presence of aggressive factors, etc.

THE SAN 5-1 TYPE MONITORING SYSTEM – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS	
PARAMETER	VALUE
System power supply	from 9 to 36V DC or from 90 to 370 V DC (from 90 to 240 V AC)
Input voltage tolerance	±15 %
Power consumption	5 W
Battery voltage (DC)*	24 / 48 / 110 / 220 V
Battery voltage measurement range	0 to 130 %
Voltage measurement precision	<0.5 %
Battery current measurement range	depending on the used I/U converter
Battery current measurement precision	<1 %
Monoblock voltage measurement range**	0 to 18 V****
Monoblock voltage measurement precision**	<1 %
Battery symmetry voltage measurement range***	0 to 220 V
Battery symmetry voltage measurement precision***	<1 %
Temperature measurement range	-40 to +100 °C
Temperature measurement precision	1°C
Binary outputs current carrying capacity	2A, 30 V DC; 0.5 A, 125 V AC
RS485 INTERFACE	
Transmission speed	9600 / 19200 / 38400 / 115200bps
Insulation of the link	2.5 kV
Link type	two-wire
ENCLOSURE	
Enclosure attachment	35mm DIN bus bar
Dimensions (W×H×D)	225×70×110 mm
Colour	RAL7035
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front
Cable entry	from the bottom and from the top
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer;
** – for the SAN 5-1 system in configuration 1;
*** – for the SAN 5-1 system in configuration 2;
****– for 12V monoblocks.

THE UKB FUSES CONTROL SYSTEM

The UKB-1 type fuses control system is used to monitor the state of the system's fuses.
UKB-1 allows monitoring fuses both in the alternating (1-phase or 3-phase) and direct voltage system circuits.
Installation is done without using any screws – it is carried out by clamping the mounting rail near the instrument.

	UKB-1-24 DC	UKB-1-110 DC	UKB-1-220 DC	UKB-1-230 AC	UKB-1-400 AC
DC power supply voltage	24 V				
Power consumption	0.5 W				
Measurement circuit voltage	24 V DC	110 V DC	220 V DC	230 V AC	3x400 V AC

View of UKB

PARAMETERS RECORDER

The SAN RP1 recorder is intended for continuous monitoring and recording of the parameters of the converter for the diagnostics system using the APSCAN network. All measurements and states of the device are stored in the internal memory of the recorder in a form of files, which are accessed via a USB external memory. The recorder is intended to be installed inside a vehicle. The internal CAN communication link is insulated. The operating state of the recorder is presented on the front panel of the device by LEDs.

View of SAN RP1

THE SAN RP1 SYSTEM CHARACTERISTICS:

- High operational stability;
- Recording of the system's operating parameters;
- CAN – 300 V insulated link;
- Cooperation with an external flash memory via the USB link (A type socket);
- Operation and recording of system logs in the internal memory;
- Indication of the following operating states:
  - power supply,
  - correct operation,
  - CAN,
  - USB occupied,
  - communication via APSCAN – transmission,
  - communication via APSCAN – load.

THE SAN RP1 TYPE PARAMETER RECORDER – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS	
PARAMETER	VALUE
Rated DC supply voltage	24 V
DC supply voltage tolerance	9 to 36V
RS485 INTERFACE	
Insulation of the link	300 V
Transmission speed	19200bp
Transmission parameters	8N1
ETHERNET INTERFACE	
Insulation of the link	100 V
Transmission speed	10 / 100 mbps
Transmission protocols	HTTP, SNTP, FTP
CAN INTERFACE	
Insulation of the link	300 V
Transmission speed	250 mbps
Transmission protocol	APSCAN
USB INTERFACE	
Transmission parameters	2.0
ENCLOSURE	
Enclosure attachment	35mm DIN bus bar
Dimensions (W×D×H)	76×92×60 mm
Colour	RAL7031
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity	5 to 80 % (non-condensing)*
Access to the device	operation and maintenance from the front
Cable entry	from the bottom and from the top
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer.

COMMUNICATION DEVICES

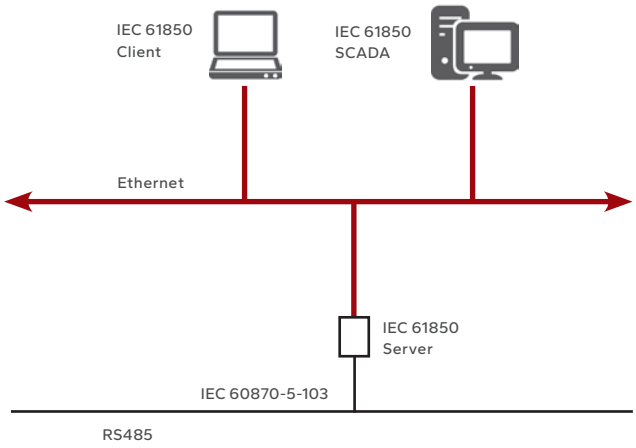
IEC 60870-5-103 / IEC 61850 PROTOCOL CONVERTER

IEC 61850 is used to configure automatics of power stations. The used protocols (MMS, GOOSE, SMV, WebServices, DNP3, and IEC 60870-5-104) operate in networks based on TCP/IP or local Ethernet networks, offering the response time shorter than 4ms. IEC 61850 has many advantages in comparison with the previously used technologies:

- automatic naming of the devices: applications that connect with devices via IEC 61850 are able to download names and description of all devices without any manual configuration;
- standardisation of names of devices: names and descriptions of devices do not belong to the producer or end user but are standardised;
- lower installation costs: the devices are connected via LAN network, not directly with each other, which allows reducing the number of cables and channels;
- lower commissioning costs: compared to the previous standards, IEC 61850 requires much less time and manual labour during configuration;
- lower expansion costs: addition of another devices to the existing systems does not generate additional costs of connections or configuration.

The SAN KP1 device is intended for conversion of data from the IEC 60870-5-103 protocol to the IEC 61850 standard. The internal RS485 and Ethernet communication connections are insulated. The operating state of the device is presented on the console via LEDs. Configuration of the device and its operating parameters is carried out remotely using an Internet browser.

View of the SAN KP1 converter



View of an example automatics system configuration according to IEC 61850

THE SAN KP1 CONVERTER CHARACTERISTICS:

- high operational stability;
- indication of the following operating states:
  - power supply;
  - correct operation;
  - communication via IEC 61850;
  - communication via IEC 60870-5-103 – transmission;
  - communication via IEC 60870-5-103 – load;
- the button used to restore default settings of the device;
- RS485 – 300 V insulated link;
- ethernet – 100 V insulated link;
- operation and recording of system logs in the internal memory.

The enclosure of the module ensures installation on a wall using a clamp on a 35mm symmetrical rail. An Ethernet cable (twisted pair), a twisted RS485 cable with a screen, and a power supply with a grounding cable must be connected to the device.

The device may be supplied from one of the two available voltages:

- 18V to 36V DC,
- 100 V to 250 V AC.

The selection of the power supply range is established by the manufacturer and depends on the device's power voltage ordered by the client.

THE SAN KP1 TYPE PROTOCOL CONVERTER – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE
POWER SUPPLY	
Supply voltage	18 to 36V DC 100 V to 250 V AC or 120 to 370 V DC (depending on the design)
Power consumption	5 W
RS485 INTERFACE	
Insulation of the link	300 V
Transmission speed	19200bps
Transmission parameters	8N1
ETHERNET INTERFACE	
Transmission speed	10 / 100 mbps
Transmission protocols	HTTP, SNTP, IEC 61850
ENCLOSURE	
Enclosure attachment	35mm DIN bus bar
Dimensions (W×D×H)	76×92×60 mm
Colour	RAL7031
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity (EN 50178 class 3k3)	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front
Cable entry	from the bottom and from the top
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer.

MODBUS RTU / SNMP PROTOCOLS CONVERTER

AGENT-APS2 is used to share the device's operating parameters in the Ethernet network using the SNMP protocol. This is a converter that converts the Modbus RTU protocol read using the RS232/RS485 serial interface to the SNMP network protocol.

THE AGENT-APS2 CONVERTER CHARACTERISTICS:

- the Ethernet interface 10 mbit/s;
- the RS232 serial interface configurable up to 230400bps;
- the RS485 serial interface configurable up to 230400bps;
- a green status LED confirming power supply to the device;
- a red status LED confirming activity on the RS485 / RS232 interfaces;
- a possibility to read data from 8 devices via the Modbus RTU protocol;
- a WWW server allowing configuration, remote reset, and preview of the device's state;
- the SNMP server used to read operating conditions of the monitored devices and support sending notifications to the selected IP addresses of the devices from the NMS Trap list;
- limitation of access to reading of parameters via the NMS address list, considering the names of groups used to read and store the parameters;
- the DHCP client;
- a mechanism used to search devices in the network, with a dynamic assignment of network settings;
- the WWW server ACL access control list that enables access to the device only to the selected IP addresses;
- convenient installation on the DIN 35mm bus bar.

View of the AGENT type protocols converter

THE AGENT TYPE PROTOCOLS CONVERTER – TECHNICAL CHARACTERISTICS – STANDARD PARAMETERS

PARAMETER	VALUE
DC POWER SUPPLY	
Supply voltage	7 to 26V
Power supply current	130 mA
Power supply current range	110 to 300 mA (depending on the load of the serial interfaces and the power supply voltage)
RS232 INTERFACE	
The scope of changes of the output voltage on the TXD lines	±10.0 V (without load)
The scope of changes of the input voltage on the RXD lines	max. ±30.0 V
RS485 INTERFACE	
The range of abc output differential voltage (A, B)	3 V
The range of output differential voltage A, B	-7.5 to +12.5 V
I/O PORTS	
Serial resistance	100Ω
Serial resistance range	90 to 110Ω
Pull-up resistance	4.7kΩ (3.3V port pull-up voltage)
Pull-up resistance range	4.23 to 5.17kΩ (3.3V port pull-up voltage)
Maximum output current range	-2 to +2mA
High output voltage	1.6 to 5 V
Low output voltage	0 to 0.45 V
Weak pull-up current	0.5 to 0.75mA
ENCLOSURE	
Enclosure attachment	35mm DIN bus bar
Dimensions (W×D×H)	104×58×85mm
Colour	RAL7035
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front
Cable entry	from the bottom and from the top
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer.

RS232 / RS485 CONNECTOR CONVERTER

The SAN 4-14 converter is a device that enables efficient cooperation between devices of different manufacturers. It translates external devices transmission protocols to the SAN external protocols.

Data transmission speed on RS links may be changed according to the EIA standard. Links for communication with an external device is insulated.

SAN 4-14 CONVERTER CHARACTERISTICS:

- high operational stability;
- indication of the following operating states:
  - system operation,
  - RS link communication;
- RS232 insulated link;
- RS485 insulated link.

THE SAN 4-14 TYPE LINK CONVERTER – TECHNICAL CHARACTERISTICS

PARAMETER	VALUE
DC POWER SUPPLY	
Nominal power supply voltage	24 V
Power supply voltage tolerance	5 to 27V
TRANSMISSION	
X1 RS485 / RS232 serial link transmission speed	38400*
X2 RS485 / RS232 serial link transmission speed	9600*
ENCLOSURE	
Enclosure attachment	35mm DIN bus bar
Dimensions (W×D×H)	55×110×70 mm
Colour	RAL7032
OPERATING ENVIRONMENT	
Operating temperature (EN 50178 class 3k3)	+5 to +40 °C*
Storage temperature (EN 50178 class 1k4)	-25 to +55 °C*
Humidity	5 to 85 % (non-condensing)*
Access to the device	operation and maintenance from the front
Cable entry	from the bottom and from the top
Maximum height above the sea level without change of the rated parameters	1,000 m ASL

* – it is possible to design different parameters upon agreement with the manufacturer.

VISUALISATION PROGRAM

The SAN DIR visualisation program is used for quick collection and displaying key information about the state of the monitored devices. It is adapted to monitoring (collecting data) many devices connected using multiple RS-232 / RS-485 bus bars in protocols, APS6000, Modbus RTU or Modbus TCP on the Ethernet link.

The program allows sending collected data to the superior monitoring system in the Modbus RTU / IEC 60870-5-103 protocol on the RS232 / RS485 link or Modbus TCP protocol on the Ethernet link. It is possible to configure it in a way to make a locally operating SAN DIR program that collects data through RS to send data through Ethernet to another SAN DIR program installed on another PC within the network. This way, you may implement supervision of many stations.

In practice, it means the possibility to monitor any device produced by APS Energia or any third party device that communicates via the Modbus RTU or Modbus TCP protocol.

SAN DIR enables remote monitoring of devices within a computer network. With an appropriate network configuration, monitoring via the Internet is also possible from any location.

DESCRIPTION OF THE SAN DIR SOFTWARE OPERATION

THE PROGRAM CONSISTS OF TWO MODULES:

Monitoring Module – used to monitor the current state of the installation. Reporting Module – used to browse and analyse archive data.

MONITORING MODULE

Main screen – presents the monitored devices in a graphical form. It allows assessing the state of the entire monitored installation and detecting groups of devices, e.g., devices installed in a given distribution board or selected signal groups (e.g., all rectifiers).

Particular elements of the system are highlighted with one of four colours that determine the status or state of the device: OK, WARNING, ALARM, NO COMMUNICATION.

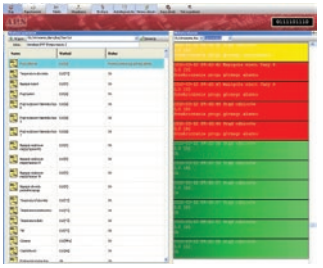
The colour of the graphical element corresponds to the worst (from the point of view of correct operation of the system) status of signals represented by this element.

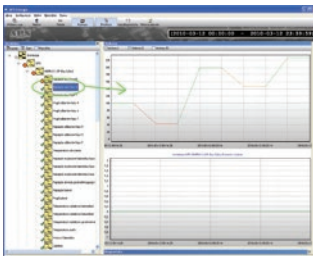
REPORTING MODULE

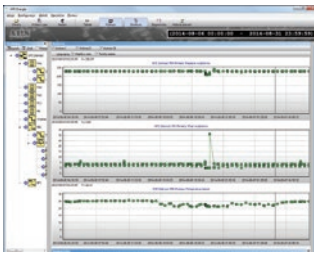
The program records data related to parameters and states of monitored devices, and enables browsing the parameters and states recorded during operation. The archive is stored in the archiwum.dat file in the catalogue with the current installation. If the file is too large, it may be transferred to another place or deleted if the archive data are not longer needed. A copied file may be browsed using the archive module of the program installed on another PC.

History may be viewed as a selected record or browsed by defining the analysed period of time. Data may be browsed in a form of summary tables in a form of graphs.

The Reporting Module enables quick analysis of the variability of the data in the time function through observation of the changes of values of signals on the generated graphs. Displaying the course of the signal on the graph is done in a simple and intuitive manner by dragging a signal from the signal tree and dropping it on the selected graph format (one of three possible).







The graphical representation strictly depends on the list of facilities, devices, and signals.

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